Sus

5/6

Ex Libris
J. M. Chalmers-Hunt

SHOUT
SHARE
IT

J.M. Chalmers-Hunt
purchased from
Joseph of Charing Cross
Rd., London in 1947
for £10. 10s

A NATURAL HISTORY OF THE

BRITISH LEPIDOPTERA

A TEXT-BOOK FOR STUDENTS AND COLLECTORS

BY

J. W. TUTT, F.E.S.,

Author of "The British Noctuæ and their Varieties," "Monograph of the British Pterophorina," "British Butterflies," "British Moths," etc.

VOL. I.

LONDON:
SWAN SONNENSCHEIN & Co., Paternoster Square, E.C.

BERLIN:
FRIEDLÄNDER & SOHN, 11, Carlstrasse, N.W.

JANUARY, 1899.

PREFACE.

In submitting this volume to the entomological public, the author trusts that the method of treatment will commend itself. The recent work that has been accomplished in the classification of the Lepidoptera by Chapman, Dyar, Packard and others, has rendered a radical rearrangement necessary. In commencing with the more generalised, and proceeding to the more specialised, superfamilies, the author considers that he has adopted a logical course that will meet with the approval of those best qualified to judge in this matter. It has been considered better to complete thoroughly a few superfamilies rather than to attempt to deal with a large number superficially, and it is hoped that the separate treatment of the main points in the life-history of each species dealt with, will be of advantage to the various classes of entomologists—synonymists, systematists, biologists, and those that study the subject under its geographical, or any one of its philosophical aspects.

A large part of a work of this description is necessarily more or less a compilation, and the author wishes here to express his obligation to those authors to whose works he is indebted for information, as well as to the very great number of entomologists (rather more than 200 in number) to whom he is indebted for local lists, and to those who have supplied him with other items of interest that have added to the usefulness and completeness of the volume. These have always been acknowledged, he believes, in the body of the work. There are many, however, who have done much more than this. To Messrs. J. H. Durrant, W. F. Kirby, L. B. Prout and Lord Walsingham, for their help in dealing with matters of "synonymy," to Messrs. A. Bacot, W. H. B. Fletcher, Drs. T. A. Chapman and J. H. Wood, for the vast amount of information relating to the "life-histories" of the insects described, to Mr. G. C. Bignell for notes on the "parasites" affecting them, to Mr. F. Lemann for copious translations from German works, to M. Oberthür for the gift and loan of many rare Anthrocerids, and to Mr. C. Fenn for the generous use of his voluminous note-books, the author tenders his sincerest and grateful thanks.

Although essentially a work on British Lepidoptera, it is trusted that it will have an interest for other than purely British lepidopterists. The chapters on each superfamily cover the whole fauna included in the superfamily, and should, therefore, be of use generally to students of these superfamilies. The "distribution" of each species, too, outside the British Isles, is considered separately from the recorded localities within the limits of our own country, and should be useful to students of geographical distribution in all parts of the world.

The author is fully aware that in a book containing so much detail, there must necessarily be many sins of commission and omission. He can only hope that these are not serious, and assure his readers that he has taken the greatest care to eliminate them.

The trouble to which the author has been put, and the hours of comparatively waste time that he has spent, in compiling the lists of localities, synonymic tables, distribution, etc., and in unearthing records of the rarer varieties and aberrations, owing to the incomplete and imperfect indexes of entomological magazines in general and works on Lepidoptera in particular, have led him to index every reference to superfamilies, families, genera, species, varieties, etc., mentioned in the book. It is trusted that this will be found of great time-saving value to all who have need to refer to the volume.

The publication of a purely technical book of this description would be practically impossible but for the generosity of a section of the entomological public who take an author on trust, as it were, and practically guarantee him against any serious financial loss. To the following ladies and gentlemen, therefore, who have in reality brought about the publication of this volume, the author tenders his heartiest thanks, and trusts that it will meet with their full approval and approbation.

LIST OF SUBSCRIBERS :—

Adams, Herbert J., F.E.S.
Adkin, Benjamin W.
Adkin, Robert, F.E.S.
Alderson, Hope, F.E.S.
Ames, (Mrs.) Sarah
Arbuthnott, H. C.
Ash, Rev. C. D., B.A.
Auckland, Lord
Bacot, A.
Bankes, Eustace R., M.A., F.E.S.
Barclay, Francis H., F.G.S., F.E.S.
Barker, Reginald H.
Bartlett, C.
Bateson, William, M.A., F.R.S., F.Z.S., F.E.S.
Beare, Professor T. Hudson, B.SC., F.R.S.E., F.E.S.
Bishop, E. B.
Blathwayt, Lt.-Col. Linley, F.L.S., F.E.S.
Bostock, E. D.
Bouskell, Frank, F.E.S.
Bowell, E. W. W. (2 copies)
Bower, B. A., F.E.S.
Bowles, E. Augustus, M.A., F.E.S. (2 copies)
Briggs, Thomas H., M.A., F.E.S.
Brown, Capt. E. W.
Brown, H. Rowland-, M.A., F.E.S.
Buckmaster, Rev. C. J., M.A.
Burnett, Basil
Burrows, Rev. C. R. N.
Butler, W. E.
Butterfield, J. A., B.SC.
Capper, Samuel J., F.L.S., F.E.S.
Chamberlain, Neville
Chapman, T. A., M.D., F.Z.S., F.E.S.
Cheesman, E. M.
Christy, W. M., M.A., F.E.S.
Clark, J. A., F.E.S.
Clarke, A. H., F.E.S.
Clarke, H. Shortridge, F.E.S.
Cotton, John, M.R.C.S.
Cowl (Mrs.), M. E.
Crabtree, Benjamin H., F.E.S.
Crass, C. H.
Dadd, E. Martin
Dalglish, A. Adie
Daltry, Rev. T. W., M.A., F.E.S.
Daws, William
Day, F. H.
Day, G. O., F.E.S.
Dent, Hastings C., C.E., F.L.S., F.E.S.
Dobson, H. T., F.E.S.
Doncaster, Arthur (6 copies)
Donisthorpe, H. St. John K., F.Z.S., F.E.S.
Dupont, L.
Eddrupp, Rev. T. B., M.A.
Edelsten, H. M.
Edwards, Stanley, F.L.S., F.Z.S., F.E.S. (2 copies)
Elwes, Henry J., F.R.S., F.Z.S., F.E.S.
Fenn, Charles, F.E.S.
Fernald, Professor C. H., PH.D., M.A., F.E.S.
Fletcher, W. H. B., M.A., F.E.S.
Freer, Richard, M.B., M.R.C.S., F.E.S.
Friedländer and Sohn (6 copies)
Garland, G. R.
Glenny, F.
Gordon, Roger S., F.E.S.
Greer, T.
Griffith, A. F., M.A.
Griffiths, G. C., F.Z.S., F.E.S.
Gunning, Montague, M.D., F.E.S.
Haggart, J. C.
Hall, Thomas W., F.E.S.
Hamm, A. H.
Hanbury, Frederick J., F.L.S., F.E.S.
Harrison, Albert, F.C.S., F.L.S., F.E.S.
Harrison, Edward S.
Head, H. W.
Headly, Charles B., F.E.S.
Helps, John A.
Hepburn, Sir Archibald Buchan, F.E.S.
Hewett, Rev. G. M. A., M.A.
Heyne, Alexander
Hill, Henry A., F.Z.S., F.E.S.
Holland, Rev. W. J., D.D., PH.D., F.E.S.
Holland, William
Horne, Arthur, F.E.S.
Image, Selwyn, M.A., F.E.S.
Jenner, J. H. A., F.E.S.
Jones, A. H., F.E.S.
Jones, F. B., M.R.C.V.S.
Kane, W. F. de Vismes, M.A., M.R.I.A., F.E.S.
Kaye, William J., F.E.S.

Lemann, Frederick C., F.E.S.
Llewelyn, Sir John T. D., Bart., M.A., M.P., F.L.S.
Lloyd, Alfred, F.C S., F.E.S.
Lloyd, R. Wylie, F.E.S.
Lowe, Rev. Frank E., M.A., F.E.S.
Lucock, Frank
Luff, W. A.
Marsden, H. W. (6 copies)
Mason, Philip B., M.R.C.S., F.L.S., F.E.S.
Massey, Herbert T., F.E.S. (2 copies)
May, H. H.
Maze, W. P. Blackburne-, F.E.S.
McIntyre, F.
Merrifield, Frederic, F E.S.
Moberly, J. C., M.A., F.E.S. (2 copies)
Moore, Harry, F.E.S.
Morton, Kenneth J., M A., F.E.S.
Moss, Rev. A. M., M.A.
Mousley, H., F.E.S.
Nevinson, Basil G., M.A., F.Z.S., F.E.S.
Newland, C. Bingham
Nicholson, Charles, F.E.S.
Nicholson, William E., F.E.S.
Ovenden, Joseph
Page, Herbert E., F.E.S.
Pearson, (Mrs.) C. N.
Peed, John
Phillips, Hubert C., M.R.C.S., F.E.S.
Pitman, M. A.
Porritt, George T., F.L.S., F.E.S.
Prout, Louis B., F.E.S.
Rae, (Mrs.) E.
Ransom, E.
Raynor, Rev. Gilbert H., M.A.
Reuter, Professor Enzio, PH.D., F.E.S.
Reid, William, F.E.S.
Reid, Capt. S. G., F.E.S.
Riding, William S., B.A., M.D., F.E.S.
Robertson, Major R. B.
Robinson, George
Robson, John E., F.E.S.
Rothschild, Hon. Nathaniel C., B.A., F.Z.S., F.E.S.
Rothschild, Hon. Walter, F.Z.S., F.E.S. (2 copies)
Routledge, George B., F.E.S.
Russell, A., F.E.S.
Russell, S. G. C., F.E.S.
Sheldon, W. G.
Smetham, Henry
Smith, W. Hawker-
Snellen, Pieter Carl T., Hon. F.E.S.
Steck, Dr. Theodor
Studd, E. F. C., M.A., B.C.L., F.E.S.
Tarbat, Rev. J. E., M.A.
Thornhill, W. B.
Thornthwaite, W., F.R.A.S.
Tunaley, Henry, F.E.S.
Tunstall, Wilmot, F.E.S.
Tunstall, Thomas
Turner, H. J., F.E.S.
Waldegrave, The Rt. Hon. Earl
Walker, Samuel
Walsingham, The Rt. Hon. Lord, M.A., LL.D., F.R.S., F.E.S., etc. (2 copies)
Watkins, C. J.
Whittle, F. G.
Wilkinson, G.
Williams, H.
Wolfe, J. J.
Woolley, H. S., F.E.S.
Wright, Dudley, F.R.C.S., F.E.S.
Ashby, Herbert, F.E.S.
Nonpareil Entomological Society.

CONTENTS.

Part I.

CHAP.		PAGE.
I.	THE ORIGIN OF THE LEPIDOPTERA	1
II.	THE OVUM OR EGG	6
III.	EMBRYOLOGY OF A LEPIDOPTEROUS INSECT	16
IV.	PARTHENOGENESIS OR AGAMOGENESIS IN LEPIDOPTERA ...	23
V.	EXTERNAL STRUCTURE OF THE LEPIDOPTEROUS LARVA ...	30
VI.	INTERNAL STRUCTURE OF THE LEPIDOPTEROUS LARVA ...	54
VII.	VARIATION OF THE IMAGINES OF LEPIDOPTERA	60
VIII.	PROTECTIVE COLORATION AND DEFENSIVE STRUCTURES OF LEPIDOPTEROUS LARVÆ	76
IX.	CLASSIFICATION OF LEPIDOPTERA	102–112

Part II.

THE SPHINGO-MICROPTERYGID STIRPS	113
THE MICROPTERYGIDES	129
THE NEPTICULIDES	162
THE COCHLIDIDES (OR EUCLEIDES)	360
THE ANTHROCERIDES	383
INDEX	547–560

BRITISH LEPIDOPTERA.

CHAPTER I.

THE ORIGIN OF THE LEPIDOPTERA.

For many years entomologists have attempted to work out the line of descent by which the Lepidoptera have been evolved. McLachlan, in 1865, and Speyer, in 1870, pointed out certain broad affinities between the Trichoptera (caddis-flies) and some families of the Lepidoptera. Packard, in 1863, had also suggested a relationship between the two orders. The co-ordinal value of the two orders, however, was maintained by all these writers, and it was not until 1896 that Sharp, commenting on the pupa of a species of *Micropteryx* (probably *semipurpurella*), stated that he "considered the pupa to be that of a Trichopterous insect," and that *Micropteryx* should be referred to that order, and that, if this course were not adopted, he felt clear that Trichoptera could not be maintained distinct as an order from Lepidoptera. Chapman had previously described* at length the pupal jaws of *Micropteryx*, and pointed out that they exhibited characters quite unique among the Lepidoptera.

There is, however, a group of Lepidoptera, in some respects, probably, more generalised than the MICROPTERYGIDES. These are the ERIOCEPHALIDES—comprising the British species, *calthella*, *seppella*, *aruncella*, *thunbergella* and *mansuetella*. Walter† discovered that the imagines of *E. calthella* had maxillæ constructed on the type of those of biting or mandibulate insects. Chapman has described‡ the way in which the jaws are used in eating the pollen. The generalised mouth-parts of *Eriocephala* consist of maxillary lobes, mandibles, etc., but not only do they differ from all other Lepidoptera in this particular, but the thorax and abdomen of the imago are also more generalised. Both the MICROPTERYGIDES and the ERIOCEPHALIDES have the fore- and hind-wings united by a jugum, and, in this respect, as well as in the highly generalised condition of the neuration, they resemble the Trichoptera.

Another super-family with Trichopterygid affinities is the HEPIALIDES. Speyer, in a very interesting paper§, refers to the similarity of the neuration of the *Hepialidae* and *Cossidae*, and remarks that they resemble the Trichoptera no less than the *Micropterygidae*, though the *Hepialidae* exhibit other close analogies with the Trichoptera. He also adds that the middle cell of the wing in the *Phryganeidae* is not fundamentally different from that of the *Hepialidae*, *Cossidae* and *Micropterygidae*, whilst the hind-wings of the *Psychidae* exhibit similar characters.

---

* *Trans. Ent. Soc. London*, 1893, p. 263.

† *Jenaische Zeitschrift*, 1885.

‡ *Trans. Ent. Soc. London*, 1894, p. 338.

§ *Stett. Ent. Zeitung*, 1870.

This brief summary indicates the directions in which it has been suggested that the Lepidoptera are allied to the Trichoptera. The nature of the alliance has been variously discussed, but the general conclusions reached fall into one of two lines:—(1) That the Lepidoptera have descended by way of the MICROPTERYGIDES, HEPIALIDES, and PSYCHIDES directly from the Trichoptera. (2) That the Trichoptera and Lepidoptera have developed from a common ancestor.

To discuss this matter satisfactorily we must first consider the similarities between Lepidoptera and Trichoptera. The resemblance between their larvæ is very strong, their external structure being almost the same, the principal difference being that the lepidopterous larva possesses abdominal prolegs. These, however, are absent in Micropterygid larvæ, as well as in other lepidopterous larvæ whose habit it is to mine into their food-plants.

The similarity of the pupa of *Micropteryx* to that of the Trichoptera has been already noticed. The abdominal segments of both are more or less freely movable upon each other. They form the "Pupæ Liberæ" of Packard, whilst those generalised lepidopterous pupæ, which have a considerable number of free (movable) abdominal segments, the "Pupæ Incompletæ" of Chapman, are much nearer to the ancestral forms than the "Pupæ Obtectæ," which represent the more specialised forms.

The lepidopterous pupa has been looked upon as presenting a subimaginal condition of a type midway between the ametabolous and metabolous orders of insects. This has been suggested by the condition of the pupal wing-cases, which are similar to those of metabolous nymphs, such as Dermaptera, *Termitidae*, *Psocidae* and Hemiptera. Spüler has shown that the neuration of the lepidopterous pupa is almost identical with that of the *Blattidae* and *Fulgoridae*. Packard says that the "wings of the lepidopterous pupa may be said to be in the nymph stage of the ametabolous insects mentioned, since they are direct outgrowths from the tergites of the segments from which they arise." He further says that "if the wing-cases of any lepidopterous pupa, together with the meso- and meta-thorax are, before the larval skin is moulted, removed and spread out," it will be seen that "they bear, as Spüler shows, a striking resemblance to those of a beetle, *Termes*, *Psocus*, or any hemipterous insect." He further points out that the pupal neuration, as well as the appendages—maxillæ, labium and legs—are ancestral and phylogenetic, showing considerable differences when compared with the corresponding structures in the more specialised imago.

The importance of the pupa, as bearing on the origin of the Lepidoptera, is also very evident when the more generalised forms of the lepidopterous pupa are compared with the more generalised forms of the dipterous pupa, as exhibited by the *Bibionidae*, *Tipulidae*, etc. Packard asserts that the close resemblance between the orthorhaphous dipterous pupa and Tineid pupa, affords strong evidence that the two orders are not only very closely allied, but even that they may have originated from a common ancestry, the loss of thoracic, and of abdominal, limbs, and the reduction of the head and its appendages in dipterous larvæ, as well as the reduction of the hind-wings, being due to modification from disuse. In the dipterous pupa, as exemplified by *Culex*, the hind pair of wings is nearly as well-developed as are those of lepidopterous pupæ.

There appear to be many Neuropteroid characters in the imagines of the more generalised Lepidoptera, and these have been, of course, those from which the phylogeny of the order has been principally studied. There are the square head, the small eyes, the vestigial mandibles; the retention of the maxillary palpi, and of the lacinia and galea (or rather the homologues of these in the form of the maxillary lobes) in the ERIOCEPHALIDES; the large meta-thorax with separate scuta, the exserted large male genital armature of the MICROPTERYGIDES and the PSYCHIDES; the Trichopterigiform neuration of Hepialids and Eriocephalids, etc. As we pass from the more generalised to the more specialised forms of Lepidoptera, these characters become exceedingly modified, and are often entirely lost.

We have before pointed out that Speyer was one of the first to show the resemblance of the Hepialid, Cossid, Micropterygid and Psychid neuration to that of the Trichoptera. He also pointed out the fact that there were certain Lepidoptera—*Heterogenea*, *Adela*, *Micropteryx*—whose pupæ possessed free limbs, and also that certain species of both orders spin a cocoon. Speyer, however, was inclined not to consider the Lepidoptera as descending directly from the Trichoptera, but that both had a common origin, the latter being the first to appear, and that the common ancestor probably had an aquatic larva. He further noticed that their mouth-parts were, in reality, very similar. The close relationship between the Trichoptera and Lepidoptera was also shown by Müller, who claimed that there was the closest affinity between the *Phryganeidae* and the Lepidoptera, and that both had proceeded from a common stock. Packard, however, shows* that there is considerable difference between the mouth-parts of the two orders, and concludes that, with respect to the structure of the maxillæ, the Lepidoptera are nearer the ametabolous mandibulate insects than the Trichoptera.

The same author also compares the neuration of the ERIOCEPHALIDES and the MICROPTERYGIDES with that of *Amphientomum*, a generalised Psocid, and he considers it "not impossible that these insects, with their reduced pro-thorax and concentrated or fused meso- and meta-thorax, together with their maxillary fork, may have had some extinct allies, which were related to the remote ametabolous ancestors of the Lepidoptera."

Hermann Müller has also suggested a close relationship between the *Tipulariae*, the Lepidoptera, and the *Phryganeidae*, and compares the similar neuration of *Limbnobia* and *Ctenophora* with that of the Phryganeids, and states that "it is far easier to deduce morphologically the proboscis of the *Tipulae* from the buccal organs of the *Phryganeidae* than from those of any other order of insects."

Chapman's studies of the pupa have led him to make some important statements* on the probable origin of the Lepidoptera. He considers that the history of the evolution of the lepidopterous pupa has been largely an attempt to solve the question as to how to escape from the pupa without the aid of imaginal jaws. Without going into the question of how the quiescent pupa of bees or beetles was derived from the active larva-like pupa (if the term, indeed, is at all applicable), such as those of bugs and crickets, he shows that "the great mass of Coleoptera and Hymenoptera have a pupa of very uniform type, helpless from its quiescence, and hence resorting for protection to some cocoon or other cavity;" these pupæ have (as a rule) a very delicate cutaneous structure, and possess no hard chitinous parts. There are many exceptions in these two orders in which the pupa is exposed, and consequently of harder external texture.

---

* *Bombycine Moths of America*, 1895, p. 55.

So far, then, there is considerable similarity in the needs of many of the pupæ of Lepidoptera, Coleoptera and Hymenoptera, and the necessity of special modification to allow the imagines in all to escape from the cocoon is evident. In the Hymenoptera and Coleoptera this is effected by the imaginal jaws, for the imago becomes perfect within the cocoon, and it not only throws off the pupal skin within the cocoon, but remains there till its appendages have become fully expanded, and more or less completely hardened. In some instances—the *Cynipidae*—the jaws are required for no other purpose.

Chapman states that one or two of the Neuropterid families appear, in this particular, to have followed out precisely the same lines as the Coleoptera and Hymenoptera, whilst others, having developed a quiescent pupa of delicate structure, have retained well-developed mandibles, by means of which the pupa escapes from the cocoon immediately previous to the emergence of the imago. This peculiar structure associates, of course, the Neuropterous insects possessing it, the *Phryganeidae*, and the MICROPTERYGIDES. Although the connection between the two latter is evident, yet Chapman points out that there are objections to Sharp's proposal to class the Micropterygids with the Phryganeids, the most important of which is, that the former have lost the imaginal jaws, and possess a distinctly lepidopterous haustellum. The phytophagous habit, too, although strong in the Phryganeids, is absolute in the Micropterygids, so that the affinities of the latter are rather with the Lepidoptera than the Trichoptera.

The Coleoptera and Hymenoptera, however, as a rule, require imaginal jaws for the purpose of obtaining food. This is not so in the Lepidoptera, nor in the other highly specialised order, the Diptera. Having no special use for imaginal jaws, these orders have not retained them simply to escape from the cocoon, but have met the difficulty of escape from the cocoon, without the aid of imaginal jaws, by various modifications. Up to a point their solutions were very similar, although in the most specialised Diptera one or two remarkable advances have been made, of which there is no trace in the Lepidoptera. Taken as a whole, then, there is much similarity between the lepidopterous and dipterous pupæ. Chapman states that he sees every reason to believe that the Diptera also originated from a Neuropterous base with the Lepidoptera.

As throwing further light on the affinities which exist between the Lepidoptera and Trichoptera, Kellogg records that the mode of tying the fore- and hind-wings together by a jugum, such as exists in the Hepialids and Micropterygids, is the same as obtains in many of the Trichoptera. He further found, in a study of the scales of the Lepidoptera,[*] that, in addition to the ordinary specialised lepidopterous scales, there was, on the wings of the MICROPTERYGIDES and HEPIALIDES, a covering of very fine hairs, differing radically from the scales in size, arrangement, and mode of attachment to the membrane, and he considers that these hairs are practically identical with the clothing of the wings of the Trichoptera, only that they are in a more generalised state. On the other hand, he finds on the wings of the Trichoptera, in addition to the fixed unstriated hairs, a sparse covering of specialised hairs, striated, set in sockets, and easily rubbed off, which he looks upon as the lepidopterous scale in a generalised state. He concludes that the stem-form of the Lepidoptera possessed a wing-clothing very much like that now exhibited by the Trichoptera.

---

* *Trans. Ent. Soc. Lond.*, 1896, pp. 567-569.

In another paper[†], Kellogg shows that the mouth-parts of the Trichoptera bear considerable affinity with those of Lepidoptera. He says that "the maxillæ and labium in general characters are similar in the two groups," whilst "the matter of the mandibles is of special interest. In certain species of *Micropteryx* (*i.e.*, in the Eriocephalids) they are present as functional organs, although the tendency towards their reduction is fully displayed within the limits of the genus. In Trichoptera, functional mandibles have not yet been found, although the distinct rudiments of mandibles are present. Manifestly now, as the tendency of specialisation in both groups is towards a reduction to complete atrophy of the mandibles, the JUGATÆ cannot be looked upon as in any way lineal descendants of the Trichoptera. The affinity of the two groups must be of the character of two dichotomously divided lines of descent, diverging from a racial type, which possessed conditions of mouth-parts, wing-neuration, wing-clothing and thoracic structure, of a character suggested by the present conditions of the organs presented by the generalised members of the two groups."

Still another paper[‡] by this author throws considerable light on the subject under discussion. By the comparison of the lepidopterous neuration, as exhibited in *Micropteryx* and *Hepialus*, with that of the Trichoptera as exhibited by *Neuronia*, as also with that of *Panorpa*, he shows that the similarity of the neuration is very considerable, and states that, on the fore-wings of all, "the simple unbranched subcostal (nervure), the five-branched radius, the persisting stem of media coalescing at its base with cubitus, the three branches of media, and the reduced anal field, are common characters. In the hind-wings, the general character of the neurational uniformity is only varied by differences which, in themselves, are additional evidences of a community of plan." It is impossible here to discuss this particular phase any further, and we can only state the author's conclusion, that the Trichopterous and Lepidopterous wings "may have had a generalised prototype very like the Mecopterous wing."

Meyrick also refers to the close similarity existing between the neuration of *Palaeomicra*, a New Zealand genus of the ERIOCEPHALIDES, and that of *Rhyacophila*, a genus of Trichoptera. The only important difference is, that in *Rhyacophila* there is an additional nervure arising out of 4 (lower median, Meyr.) in the fore-wings, although it is interesting to observe that this very nervure has disappeared in the hind-wings. Nothing at all approaching this form of neuration is known in any other order of insects, and Meyrick considers that it is highly improbable that so complex a type could have originated twice independently.

---

[*] *The Taxonomic value of the scales in the Lepidoptera*, pp. 45-89.

[†] "The mouth-parts of Lepidoptera," *American Naturalist*, 1895, p. 546 *et seq.*

[‡] "The affinities of the lepidopterous wing," *American Naturalist*, 1896, p. 709 *et seq.*

It may be observed from the above summary of the latest facts at our disposal on this subject, that the opinion is pretty generally held that the Lepidoptera and Trichoptera originated from a common neuropterous stock. It is not probable that either originated directly from the other, but it is very possible that they branched quite independently, and so represent two distinct lines of descent, originating from a common ancestral base. There is also considerable probability that the Diptera originated from the same source, as this order shows considerable affinity with the Lepidoptera.

CHAPTER II.

THE OVUM OR EGG.

IT would appear that there is a tendency for the eggs of all organised beings to assume a more or less ovoid or spherical form. Among the eggs of Lepidoptera this general tendency is well maintained, and we find them roughly divisible into two forms: (1) Ovoid, longer than high, with the long axis horizontal, a shorter axis vertical. (2) Upright, more or less spherical, with the horizontal axes practically equal, the vertical axis equal, longer, or shorter than the horizontal.

The primeval lepidopterous egg was probably ovoid, colourless and transparent, with no sculpturing on its cell wall. This form of egg is practically that which is laid by the Micropterygids, Adelids, and other Lepidoptera that cut out a pocket in a leaf and deposit their eggs in the soft cellular tissue of the leaf. This form of egg would, if laid in an exposed situation, soon undergo modifications in many directions, arising from the need of protection and concealment, and it is possible that, under these conditions, one may find isolated examples of almost any form in any of the families, although the simplest form of egg must generally be found in the lower families, and no highly-developed structure can occur, except among the species of those families that have undergone a large amount of specialisation and elaboration.

The egg of a lepidopterous insect consists of an outside shell, enclosing protoplasm, which is, at first, homogeneous. The shell, which forms a thin pellicle, is usually divisible into a base, walls, and apex. At that pole of the egg, usually termed the apex, there is, as a rule, a microscopic depression, from the base of which minute canals lead into the egg, and carry the spermatozoa for the purpose of fertilisation. This is called the micropyle. It will be at once observed that this definition, so far as relates to the micropyle being placed at the apex of the egg, is quite conventional, for, although the micropyle is actually at the apex in spherical, or, as they are usually termed, "upright," eggs; on the other hand, it is at one extremity of the long (horizontal) axis in ovoid, or, as they are usually termed, "flat," eggs. Since the "upright" egg has more probably been evolved from the "flat" form, than *vice versâ*, it follows that, when we use the term "base" in the two forms of egg for that side by which the egg is usually attached to the surface of the food-plant, or other object on which it may be deposited, by the parent, the sides are not homologous in the two structures. In general, we speak of the side opposite the micropyle as the base. It follows, therefore, that we speak of a Noctuid egg as being laid on its base, and, to get rid of the anomaly, we speak of a Geometrid or Lasiocampid egg as being laid on its long side, whereas, as we have already suggested, the older form of egg is probably that which is laid on its long side, which should then, in reality, be called the base.

The greater number, by far, of the families which used to be included under the title of Micro-Lepidoptera have "flat" eggs; such are the Micropterygids, Tineids, Pterophorids, Gracillariids, Gelechiids, Pyralids, etc. With this group the higher Geometrids and Brephids, which also have flat eggs, may be considered. Another important group with flat eggs, consists of the Zygænids, Lasiocampids, Saturniids and Sphingids. The Lepidoptera with upright eggs are the Cossids, Cymbids (Chloëphorids), Notodonts, Noctuids, Liparids, Arctiids, Hesperids and Papilionids. There are, undoubtedly, a few of the so-called Micro-Lepidoptera with upright eggs, *e.g.*, *Chrysocorys festaliella*, but very little is known of the eggs of these moths.

The base of a lepidopterous egg, then, as hitherto used by entomological authors, is a doubtful quantity. It has been considered by some as that side by which it is attached to its food-plant; it has been considered by others as that side opposite the micropyle. We use it in the latter sense, as tending to preserve correctly the homologies of the egg structures.

The side by which an egg is attached to any object is usually flat and devoid of characteristic markings, but the walls are generally sculptured in some form or other, although they are, in a few cases, quite smooth. The flat eggs are, as a rule, ornamented only with rough pittings, worked up in some cases into a roughly polygonal reticulation; they rarely have longitudinal ribs, although certain Geometrids—Gnophids and Acidaliids—exhibit this style of ornamentation. The eggs of Geometrids offer many remarkable modifications in their sculpture, from the almost smooth egg of *Tephrosia*, to the marvellous polygonal reticulation (with a white knob at each angular point) presented by *Eurranthis plumistraria* and *Hemerophila abruptaria*. The Zygænid egg is characterised by its bright yellow colour, with one pole quite transparent; the Lasiocampid egg by its tiny raised points at the angulations of the finest conceivable reticulation, and by its opalescent markings. The Sphingid egg is almost devoid of markings, the micropyle often being practically indistinguishable.

In the upright eggs, however, the ornamentation becomes much more complex. The pitting takes the form, generally, of hexagonal cells, and longitudinal ribs stand out from the surface of the egg, and run from the base to the apex of the egg, the ribs being generally lost on the edge or rim of the micropylar depression. In the Noctuids this hexagonal cell structure, which is separated by the longitudinal ribs, is entirely lost, and there is a series of transverse ribs running parallel to the base, dividing the depressions between the longitudinal ribs into a series of ladder-like spaces. This is also a common form of sculpture in the Pierid and Nymphalid eggs.

The micropyle is usually placed at the base of a slight depression situated at the summit of an upright egg (*i.e.*, at the extremity of its vertical axis), and at one of the ends of the long (horizontal) axis of a flat egg. It consists of a number of delicate microscopic canals, which vary in number, but there are rarely less than four or more than six. They radiate from a minute depression, surrounded by a rosette or circle of cells of the greatest delicacy. In some eggs, even when viewed under a powerful lens, no alteration in the ordinary outline of the egg is caused by the micropylar depression; in others, however, where it is more depressed it is readily distinguished. In some eggs, again, there is a considerable micropylar basin, the micropyle proper being situated at the base of this.

The upright egg, as we have seen, exhibits what is probably the most specialised type, and we find the eggs of some Noctuids and Papilionids very highly specialised. The Noctuid egg is usually of a hemispherical shape, somewhat flattened at the base, but those of the Xanthids have raised ribs rising above the central point, or apex, and curving down thereto; they are, therefore, not unlike, in a general way, the egg of a Vanessid. The egg of *Phytometra viridaria* (*aenea*) is cut up by two sets of oblique lines into diamond shaped spaces, at each point of which there is a large red-brown spine, standing perpendicularly to the surface of the egg. But the eggs of certain Papilionids are, probably, the most specialised. Among these, the Vanessid egg is of a barrel-shape, with eight or ten highly developed longitudinal ribs. The nine-pin shaped eggs of the Pierids may have as many as thirty or forty longitudinal ribs, whilst the tiarate eggs of the Lycænids have a most complicated ornamentation, owing to the prominence of the longitudinal ribs, and the depth of the transverse pitting. The egg of *Polyommatus corydon*, with its dahlia-like appearance, must be seen under a microscope to be appreciated, whilst those of *P. icarus* and *Plebeius aegon* are equally complicated and beautiful. The egg of *Thecla w-album* has a series of layers of prominent white pointed cells forming a saucer-like base, which holds a flat, truncated cone of a dark reddish colour, with a conspicuous, circular, micropylar basin at the summit. The egg of *Limenitis sibylla* is covered with fine transparent hairs, resembling spun glass. In cross-section, too, the Lycænid egg gives a polyhedral or hexahedral appearance, and not the more or less circular one common to butterflies.

There are other peculiarities that may now be briefly noticed. The typical Geometrid egg is usually oval or ovoid in form, with a depression on the upper face, but in *Ennomos*, it assumes the appearance of a rather square-based parallelopiped, and a somewhat similar shape is seen in the egg of *Crocallis elinguaria*. *Brephos* and *Thyatira*, which have been placed by various systematists among the Noctuids, have eggs of Geometrid appearance. The eggs of Tortricids and Cochliopodids have the appearance of flat scales, and so have those of many Pyralids.

We have seen that certain families are characterised by their species possessing a flat egg, and that others are characterised by their species possessing an upright egg. The Lasiocampids have a flat egg, yet the eggs of *Eriogaster lanestris* and *Clisiocampa neustria* and *C. castrensis* have the appearance of upright eggs, so far as their position with regard to the twig on which they are laid is concerned. This, however, is not really so, for the eggs are laid upon their long sides, on each other. A case of precisely opposite character occurs among the Noctuids, the eggs of *Leucania littoralis* being laid on their sides upon (or against) each other, although theoretically, no doubt, they may be assumed to be laid uprightly upon the edge of the fold of the leaf, in which they are placed.

There is considerable difference in the thickness of the eggshell of various lepidopterous eggs. In many species, it is so thin that the development of the embryo can be distinctly traced through it. The eggs of Tortricids and Pyralids are specially remarkable for the thinness of their shells; but, even in the same super-family, there is considerable difference. Among the Papilionids, the shells of *Vanessa io*, of *Pararge* and of *Nemeobius*, are very delicate; those of the Lycænids and Pamphilids are particularly tough and opaque. The eggshells of *Leucania littoralis* among the Noctuids, of *Callimorpha hera* and *Euthemonia russula* among the Arctiids, of all the species of the Zygænids, are all exceedingly delicate.

When the egg is first laid, the outer pellicle is soft and yielding, and, if it be disturbed ever so slightly, an impression is made in its external appearance. In some cases, the egg, when first laid, is exceedingly soft, and looks as if it were almost fluid. Such eggs, laid on glass, apply themselves to it, and have a very regular and almost perfectly circular or oval outline; but if laid on a leaf or other irregular surface, they apply themselves to its irregularities, and become themselves irregular, both in relation to the surface to which they are applied, and also as regards their disturbed outlines. Chapman refers to the evident irregularity observable in eggs laid by *Scopula decrepitalis* on a *Teucrium* leaf. The base of the eggs of *Colias* sometimes spread considerably; the eggs of *Gonepteryx rhamni* are often flatter on one side than the other. Eggs of *Pieris* and *Euchloë* also show a basal flattening that would probably not occur if they were quite free. The egg of *Calligenia miniata*, which has a very Pierid appearance, varies much in shape, some eggs being much stumpier than others. The variation in the shape of the eggs of *Tephrosia bistortata* and *T. crepuscularia* (*biundularia*), even when laid quite free, is considerable; whilst the eggs of these species, as well as those of *Anchocelis litura*, *A. pistacina*, *Orrhodia vaccinii*, *O. ligula*, *Dicycla oo*, and others, pushed into crannies of bark, may sometimes become so altered by the process, that the typical shape and ribbing are entirely lost. This is the case also with the eggs of *Leucania littoralis*, which are laid, as before noticed, in the folded edge of a leaf. In eggs of this description, it need hardly be said, the change in shape has no injurious effect on the development of the embryo.

There is, sometimes, considerable difference in the size of eggs, even when laid by the same moth. Harwood has noticed differences in the size of the eggs among the Notodonts, and is inclined to associate the difference in size with a difference in sex, assuming that the larger eggs produce females, the smaller, males. Hellins observes that of about twenty-three eggs laid by a female *Smerinthus populi*, the last laid eggs were only two-thirds of the size of those first laid. Chapman has recorded that there is considerable variation in the size of eggs laid by the various species of Acronyctid moths. In *Triaena tridens* there are, apparently, at least two races which lay differently sized and differently ribbed eggs, whilst the eggs of *Pharetra euphorbiae* var. *myricae* also vary very much in size.

The eggs of Lepidoptera do not vary much in colour when first laid. They are usually whitish, pale yellow, or pale greenish in tint, but, after they are laid, they change colour very quickly, and the colour then probably becomes of that hue which will most exactly harmonise with the surroundings among which the egg is usually laid. The eggs of *Thecla w-album* are laid above, or directly below, an aborted leaf-bud, and harmonise so exactly with the colour of the bark of the elm-twig on which they are placed, that only an entomologist could possibly detect them. They appear to be placed always on the old, and not on the growing twigs, and thus everything tends to aid in their protection.

The first colour-change of the lepidopterous egg usually takes place within a few hours (12-72) of an egg being laid. After this first colour-change, many eggs undergo a whole series of complicated colour-changes, due to the development of the embryo within, the changes being easily followed through the transparent egg-shell. Robson says that the change of colour of the newly-laid Hepialid egg, from white to black, is a change in the colour of the shell only, and this is so, for the egg-shell remains black after the young larva has left the egg. Many eggs, however, like those of the Hepialids, change colour but once (directly after being laid). The egg of *Euchloë cardamines* is yellow when laid, becomes deep orange in about twenty-four hours, and, with the exception of a slight change just before hatching, remains of this tint. The egg of *Endromis versicolor* is pale green when laid, rapidly becomes yellow, then changes to orange, and finally to purple. Jordan records an opaque white egg of *Cerura vinula*, instead of the usual chocolate-coloured egg. Hellins observes that eggs of the same species vary in colour, and do not always go through the same changes of colour when approaching maturity. He instances *Orgyia antiqua*, *Cerura vinula*, *Hepialus sylvinus*, and *Cheimatobia brumata*. The changes which Chapman has chronicled* as taking place in the Acronyctid eggs while maturing, are exceedingly interesting. These changes may vary according to temperature, the colouring of *Pharetra rumicis*, which is assumed in two days in warm weather, taking a week in cool weather. The egg of *Leucania littoralis* is at first pale yellow, then it becomes orange, then mottled with reddish, and at last slightly purplish, at which stage the shell itself is seen to be perfectly transparent, and the embryo may be observed within the egg-shell. The egg of *Acontia luctuosa* is pale yellow, then whitish with a row of red-brown spots just above its equator. The egg of *Phytometra viridaria* is pearly white, then it develops two bright claret-coloured rings, one of which surrounds the micropylar area and the other the shoulder of the egg; after this the red areas become enlarged, and tend to join. Many eggs exhibit a similar wide series of colour-changes during the development of the embryo.

---

* *Entom. Record*, etc., v., pp. 140-146.

It will be at once manifest, if an egg be kept under observation under the microscope, that most of the colour-changes taking place within the egg are very closely connected with the developmental progress made by the embryo. The first change, which occurs very soon after the egg is laid, probably represents the transition of the egg-contents from their primal homogeneous condition, to that which is reached when the blastoderm layer is developed, and which is accompanied by the separation of the contents from the egg-wall. There is, at this stage, sometimes, a distinct change of tint, at others, the whole surface becomes completely covered with black dots.

The second change appears to take place with the formation of the germinal band, and appears to be intensified as the growth of the embryo continues. This probably accounts for the general darkness of the colour assumed at this stage ; dark brown, red, purple and leaden are tints frequently met with, and these sometimes last for a considerable length of time.

The third change of colour usually exhibits an intensified form of that occurring in the previous stage, except that the apex, and frequently the base of some eggs, becomes pale again. Sometimes, at this stage, the egg-shell is quite transparent, and the movements of the embryo are readily observable. This is particularly the case in many eggs just previous to the escape of the larva.

Eggs also vary in their ornamentation. We have already suggested that the primitive lepidopterous egg was smooth, and, at the present time, with the exception of minute pitting and faint polygonal reticulation, the majority of flat eggs are comparatively smooth. The Geometrid egg appears to be more generally highly ornamented than that of any other flat-egged family, except, perhaps, those of the Crambids. There is, however, a very considerable amount of variation in the detail of the ornamentation, even in this group, *e.g.*, the egg of *Hemerophila abruptaria* is covered with a network of hexagonal cells, with a glistening white knob or button at each angular point, but here and there heptagonal and pentagonal cells exist side by side, where one of the knobs has migrated to an adjacent cell ; this is a common form of variation in this type of ornamentation. In the groups with longitudinal ribs the number of these often varies ; thus, in the egg of *Catocala fraxini* the number varies from 22-27, in *Polygonia egea* there may be 9 or 10, in *Leucophasia sinapis* 11 or 12. Chapman says that, as a rule, the egg of *Eugonia polychloros* has eight ribs, but that sometimes there are only seven, also that *Polygonia c-album* may have ten or eleven ribs, and Edwards gives the same numbers for the allied *P. interrogationis*. Chapman finds that in *Pharetra* (*Acronycta*) *auricoma* the number of ribs varies from 57 to 60, in *P. albovenosa* from 41 to 45, in *Triaena tridens* the average number is 38, but that sometimes there are as many as 44, whilst one batch of eggs of this species had from 49 to 52 ribs. In *T. psi* the number is rarely fewer than 45, and some specimens have as many as 54 ; in *Acronicta leporina* the number varies from 41 to 63, whilst in *Apatela aceris* the number may extend from 50 to 75. It appears to be, indeed, a very general form of variation in almost all eggs with a moderate number of longitudinal ribs.

The variability in the number of ribs is almost equalled by that of their arrangement. The egg of *Cirrhoedia xerampelina* has 24 or 25 longitudinal ribs. Normally, these ribs should be alternately long and short, the former running from the base to the summit, the latter stopping short at about one-fourth the distance from the top. Really the arrangement is rather irregular; in one egg examined there were two short ribs between two successive long ones, whilst in another case the short one was missing. In the egg of *Tiliacea* (*Xanthia*) *aurago* there are 15 ribs running from base to apex, each alternate one failing before reaching the summit; but there is considerable variation in their arrangement, one, two, and even three of the shorter ones being sometimes obsolete in one egg. Theoretically, the 27 longitudinal ribs of *Dasycampa rubiginea* should be alternately long and short, but frequently two short ones are adjacent, more rarely two long ones. The manner in which the longitudinal ribs unite just before reaching the micropylar area is also very variable.

The number of eggs laid by various species differs greatly, and, among different individuals of the same species, there is considerable variation. Hellins records 1,200 as the number laid by a female *Triphaena fimbria*; Riding gives 700-800 as the number laid by *T. pronuba*; Hollis says that *Spilosoma lubricipeda* lays from 400 to 500; Nicholson gives above a thousand as the number laid by three *Peridroma saucia*; *Zeuzera pyrina* is reported to lay between 1,000 and 1,100; a female *Dasychira pudibunda* laid 274 eggs; whilst *Epunda lichenea* is accredited with laying above 200. There is no doubt that the average number laid by many species is a very high one.

The eggs are laid in a variety of ways and positions. The Hepialids drop their ova among the herbage loosely, the tiny eggs quickly finding their way to the roots of the plants on which the larvæ feed. *Lasiocampa quercûs* does the same, and so does one of the most highly specialised of our British butterflies, *Melanargia galatea*. A large number of moths lay their eggs solitarily on, or near, the food-plant of the larvæ, whilst others lay them side by side in clusters. The Zygænids often heap their eggs in two or three layers. *Clisiocampa* (*Malacosoma*) *neustria*, *C. castrensis*, *Eriogaster lanestris*, and *Anisopteryx aescularia* lay their eggs in rings around the twigs of their respective food-plants, forming a kind of necklace around the stem. The Amphidasyds (*A. betularia* and *A. strataria*), and the Tephrosiids (*T. bistortata* and *T. crepuscularia*), like *Zeuzera pyrina*, are provided with long ovipositors, to enable them to lay their eggs deep in the crevices of the bark of the trees on which their larvæ feed. The egg of *Trochilium bembeciforme* is laid on the underside of the leaf of an osier, although the larva is a borer, and feeds on the solid wood. The female *Leucania littoralis* folds over the edge of a grass leaf, and lays her eggs in a string within the fold. The Geometrid moth, *Iodis vernaria*, lays its eggs one upon the other in rouleaux, seven or eight in each row, and resembling a slender twig or tendril of *Clematis*, on which plant the eggs are laid. *Polygonia c-album* and *P. interrogationis* have a precisely similar habit. The eggs of the Pyralids usually partially overlap, and the same imbricate arrangement is found in certain Geometrids, *e.g.*, *Ennomos quercinaria*, and certain Noctuids, *e.g.*, *Mellinia circellaris* (*ferruginea*), the Acronyctid tribe, *Viminidi*, etc. This method, of course, depends largely upon the flatness of the egg. The Micropterygids and Adelids are provided with a most complex cutting apparatus, with which they cut out pockets in a leaf, and then insert an egg (or eggs) within the pocket, in the soft cellular tissue of the leaf. Sufficient examples have been given to illustrate the almost endless variety that exists in the egg-laying habit among Lepidoptera.

The eggs of Lepidoptera are usually laid upon or near the food-plant of the larva, but this is not always the case. *Triphaena pronuba* frequently chooses a piece of wire (in a fence), or cord hanging loosely in a garden, for the purpose. Riding reports batches of eggs of this species in two successive years (1895, 1896), on the meshes of a lawn tennis net. *Chrysophanus phlaeas* and *Polyommatus icarus* frequently deposit eggs on objects adjacent to the food-plant, so also, more rarely, do *Pararge egeria*, *P. megaera* and *Pieris napi*. Many ground feeding Noctuids lay on the stems of dead plants, leaves of trees, etc., and so also do *Arctia caia*, *Spilosoma menthastri*, and many other Arctiids. Riding records the finding of eggs of *Macrothylacia* (*Lasiocampa*) *rubi* on the trunk of a pine, at a height of nearly six feet from the ground, whilst a couple of the linear leaves of a Weymouth pine were girdled by 70 or 80 rows (10 eggs in each) of the eggs of a Noctuid moth, which turned out to be those of *Triphaena pronuba*. *Acidalia perochraria* appears to follow the habit of the Hepialids, *Melanargia galatea*, *Pararge achine*, etc., and to sprinkle her eggs on the ground.

In the case of eggs laid naturally upon the leaves of deciduous trees or anual herbaceous plants, the egg-stage is usually a short one. On the other hand, when the eggs are laid upon the stems, leaf-buds, etc., of plants, the egg-stage may last a considerable time. The former is the method usually adopted by Geometrids, Noctuids, Sphingids and their close allies, although the Xanthids, Catocalids, Ennomids, etc., will occur to the mind at once as exceptions. It is remarkable that those eggs laid on leaves, and on grass stems are, as a rule, of a white, yellow, or greenish hue, whilst those on the twigs of bushes and trees are of a dirty white or grey, and frequently assume a purplish or red-brown tint, *e.g.*, *Thecla w-album*, *Ennomos autumnaria*, *Endromis versicolor*, *Tiliacea aurago*, *Cirrhoedia xerampelina*, *Dichonia aprilina*, etc., and it will be found, as a general rule, that those species which hybernate in the egg-state, have eggs, which rapidly change to some dark hue that corresponds well with the colour of the stem or twig on which the egg is frequently deposited. Those that are scattered on the ground are usually of a dirt-colour, or have a pearly appearance; in fact, with a few apparent exceptions, the colour of lepidopterous eggs rapidly becomes such as to make them difficult of detection by the various predaceous creatures that prey upon them.

The peculiar resemblance of a rouleau of the eggs of *Iodis vernaria* to a broken tendril of *Clematis vitalba*, the plant on which the eggs are laid, has already been noticed. The easy way in which *Tephrosia bistortata*, *Biston hirtaria*, *Amphidasys strataria* (*prodromaria*), *Orrhodia vaccinii*, *Dicycla oo*, and their allies, pack their eggs deep into the bark crannies out of sight, attracts attention at once, because of the protection afforded. *Anisopteryx aescularia*, *Eriogaster lanestris*, *Porthesia similis*, *P. chrysorrhoea* and *Porthetria dispar* cover their eggs thickly with silky hairs from the extremity of the abdomen. *Leucoma salicis* covers its eggs with a substance that has a salivary-looking appearance, but which is quite solidified, and various other devices have been developed by individual species for the protection of their eggs, and, as a rule, it appears probable that less destruction takes place in this, than in the early larval stage of lepidopterous insects. It may be that natural selection protects one species more perfectly in one stage, another species in another stage, but, so far, young larvæ appear to be the particular form against which destructive agencies are most active.

However well eggs may be protected, it is evident that considerable destruction does take place in this stage, and it must be admitted, especially in the case of eggs laid in large batches, that if an attack thereon be made by some voracious entomophagous enemy, the destruction is absolutely complete. Scudder records that ants destroyed the eggs of a *Pyrameis cardui*, that he had enclosed on a thistle. Spiders, ants and mites, are great offenders in this direction, but probably their combined destructive efforts fall much below those of the true egg parasites—minute Hymenoptera of the genera *Trichogramma* and *Telenomus*—which lay their eggs in the ova of lepidopterous insects, and whose larvæ find sufficient nourishment therein to enable them to reach the imaginal condition. Nicholson mentions the rearing of 30 *Telenomus phalaenarum* from some eight eggs of *Macrothylacia* (*Lasiocampa*) *rubi*; Bacot records the destruction of a whole batch of *Arctia caia* eggs by the same species, whilst Bignell states that he bred 2,100 imagines, of the same parasite, from 200 eggs of *M. rubi*, an average of more than ten to each egg; Dimmock mentions the breeding of 30 hymenopterous parasites from a single egg of *Smerinthus excaecatus*. Numbers of parallel cases have been recorded in the various entomological magazines.

The duration of the egg-stage varies greatly in different species. Buckell, Fenn and Prout have given* comprehensive lists of the duration of the egg-state in a great number of Geometrid species. The shortest periods recorded are two days, in the case of *Acidalia virgularia*, four days for *Timandra amataria* and other species. On the other hand, many species, that hatch the same year, pass a much longer period in the egg-state, *e.g.*, *Selenia tetralunaria*, 23 days; *Amphidasys strataria*, 30 days; *Boarmia abietaria*, 19 days; *B. gemmaria*, 20 days; *Hybernia leucophaearia*, 38 days; *Larentia caesiata*, 24 days, etc. In some species the length of time varies in different years, probably depending on meteorological conditions. Thus, *Biston hirtaria* may take from 17 to 37 days; *Hemerophila abruptaria*, from 14 to 26 days; *Selenia lunaria* took 7 days in 1865, 12 days in 1861, and 15 days in 1886—all of the first brood. *Selenia bilunaria* has the following record:—1880, first brood, 16 days; 1883, first brood, 28 days, second brood, 16 days; 1890 and 1891, second brood, 15 days. But different broods of the same species may vary in the same year; thus, in 1865, one batch of *Camptogramma fluviata* took 5 days, another 10 days, and a third 21 days.

Of those species which pass the winter in the egg stage, the time is so great that the combined larval, pupal, and imaginal periods are comparatively very short. Thus the egg stage of *Epione apiciaria* lasts as long as 9¾ months; of *Ennomos autumnaria*, 7¾ to 10 months; of *Himera pennaria*, 5 months; of *Oporabia filigrammaria*, 4¾ months; of *Cidaria testata*, 8 months; of *Chesias spartiata*, 4½ months. The egg stage of *Thecla w-album* and *Zephyrus quercûs* lasts from July to early May; of *Thecla pruni*, from June until late April; of *Plebeius aegon*, from July to April; of *Trichiura crataegi*, from September to

---

* *Entom. Record*, etc., iii., pp. 175-176; iv., p. 255; iv., p. 292.

April; of the Catocalids, from July and August to April, and so on.

The condition of the egg during the hybernating period is very interesting. In some species, such as *Argynnis adippe*, *Pamphila comma*, *Parnassius apollo*, etc., the fully formed caterpillar remains coiled up within the shell all the winter; in others, the eggs appear to remain until spring, almost in the same condition, so far as the contents are concerned, as that in which they were laid. Buckler records that eggs of *Bombyx mori*, *Trichiura crataegi*, *Ennomos* (*alniaria*) *tiliaria*, *E. quercinaria*, *Cheimatobia brumata*, *C. boreata*, *Scotosia vetulata*, *Ptilophora plumigera* and *Polia chi*, have been examined from time to time until the middle of January, and nothing but the faintest traces of the future larvæ have been detected by a microscopic examination of their still fluid contents. In the case of *Tiliacea* (*Xanthia*) *aurago*, however, an egg was found to contain a partially developed larva on January 14th. It occasionally happens, as in the case of *Polia xanthomista* var. *nigrocincta*, that part of a batch of eggs, which should normally hybernate during the winter, hatches in the autumn, and the larvæ attempt to feed up, whilst the remainder of the batch goes over normally. It is recorded, also, that in a batch of *Orgyia antiqua* eggs, the hatching takes place most irregularly, a few larvæ appearing at a time, and the emergence of the whole brood thus spread over a long period. This happens also in *Epione apiciaria*, *Lasiocampa trifolii*, Catocalia species, etc.

The influence that temperature has on the hatching period, and on the vitality of lepidopterous eggs, has been well shown by Merrifield. He has recorded that eggs of *Selenia bilunaria*, and those of *Selenia tetralunaria*, were quite uninjured by exposure to a temperature of from 80° F. to 90° F., their development, on the contrary, being greatly accelerated. Spring-laid eggs of *S. bilunaria* began to have their vitality affected after being "iced" (at a temperature of 32° F., when they were in the central red stage), for 28 days, and none hatched after 60 days' icing. The result was even worse with spring-laid eggs of *Selenia tetralunaria*, none of which survived 42 days' icing, and some summer-laid eggs of the same species, exposed to the same conditions, fared no better. In all the experiments, up to 60 days' exposure, nearly all the eggs, after being removed from the ice, matured so far as to admit of the formation of the young larva, which could be seen through the transparent shell. The failure was a failure to hatch.

Standfuss has recorded that eggs of *Arctia fasciata*, *Dasychira abietis*, *Odonestis* (*Lasiocampa*) *pruni* and *Dendrolimus pini*, which were exposed to a temperature of 30° C. (93° F.), during the process of laying by the female, and up to the time of hatching, produced larvæ in two-thirds or less of the normal time, and there emerged as perfect insects in the same year, *i.e.*, without hybernation of the larva, in the case of *A. fasciata*, 71 per cent.; of *D. abietis*, 90 per cent.; of *O. pruni*, 100 per cent.; and of *D. pini*, 81 per cent. The larvæ and pupæ of the broods were kept, as far as possible, at a mean temperature of 25° C. The eggs of the same females as those used in the above experiment, which had already been laid at a·normal temperature (22° C.), and were left in this until hatched, afterwards remaining in the same mean temperature of 25° C., as the other larvæ and pupæ, produced a considerably smaller number of perfect insects, without hybernation of the larvæ, *viz.*, *A. fasciata*, 23 per cent.; *D. abietis*, 12 per cent.; *O. pruni*, 64 per cent.; *D. pini*, 28 per cent.

It has been suggested that the sex of the imagines reared from eggs can be determined by the conditions in regard to abundance of food, or the reverse, under which the larvæ are reared; that, under a specially nutritious diet, lepidopterous larvæ tend to produce female imagines, whilst a starvation diet tends to the production of males. This, of course, assumes a neutral condition as regards sex in the newly-hatched larva, but the experiments that are supposed to have proved this simply show that male larvæ will stand more starving than those of females, or, in other words, that the minimum food which will allow male larvæ to just pupate, is, in the same species, often insufficient to allow the process in female larvæ, which die under such extreme treatment. The sexual organs of newly-hatched larvæ are moderately well-developed.

Another theory which has been assumed, *viz.*, that eggs laid successively by the same female are of opposite sex, has been entirely disproved, and experiment has shown that the relative proportion of the sexes is subject to immense fluctuation on the separate dates on which eggs are laid. As regards eggs laid on any one day, the sexes generally succeed each other in little groups of irregular size. It is further recorded that the pupæ obtained from different batches of *Vanessa io* had a large proportion of a certain sex, some batches producing almost entirely males, others consisting almost entirely of females.

The eggs of Lepidoptera are developed in the ovaries of the parent, whence they pass down the oviduct into the vagina. In connection with the vagina are one or more pouches called receptacula seminis, in which the spermatozoa are stored after copulation. As the egg passes along the vagina to the ovipositor, the spermatozoa, or sperm-cells, are released from the receptacula, and certain of them enter the egg through the micropylar tubes, one of which fertilises the egg. Fertilisation, then, takes place at the time that the egg is being laid, by the spermatozoa entering the micropylar pores at the time that the egg passes the pouches. It is sometimes noticed that the latest-laid eggs of a moth are infertile, a result probably due to the supply of spermatozoa being exhausted before all the eggs are laid. It is well-known that many Lepidoptera pair more than once. *Anticlea berberata*, *Tephrosia bistortata*, and various Zygænid species have been observed to do so repeatedly. No doubt, the habit is of common occurrence.

CHAPTER III.

EMBRYOLOGY OF A LEPIDOPTEROUS INSECT.

It may be well now to briefly consider the changes that take place in the fertilised ovum or egg, and that have, as their result, the production of an individual resembling its parents. These changes are of the utmost importance, and the embryological studies made by various entomologists have done much to throw light upon the wider biological problems which embryology presents.

It is well known that all animals during their embryonic life undergo a series of remarkable changes, both in form and structure. The earliest embryonic appearance of widely different animals is such that it is difficult to say even to what class the embryo belongs, but as development proceeds, the characteristic features of the class are developed. When we come to consider the embryonic conditions of genera and species we find that the similarity of their early stages is much more pronounced, the likeness extending even to small matters of detail.

It is possible to limit the study of the embryology of insects to the changes that take place within the egg, but it is well known that the larvæ and pupæ of lepidoptera are essentially embryonic conditions, leading up to the production of the imagines. At the same time, their independent life, their competition in the struggle for existence, and the different conditions of their environment, have led to the formation of habits, and given rise to peculiar characters, which more or less obliterate, as it were, their true embryonic characters. It is necessary, therefore, in dealing with these stages (larval and pupal) to bear in mind two points:—(1) Whether the similarities which one sees are phylogenetic, that is, whether they are due to the transitory re-appearance of the characters of a bygone epoch in the ancestral history, or, (2) Whether they are œcological in their origin, and due to a similar relationship of the animals to their organic and inorganic environment. The characters manifested in the egg-state must almost of necessity belong to the first division; those in the active larval (considered as an embryonic) condition may belong to the first or second.

It will be seen, then, that such phylogenetic conditions as the embryological stages of insects offer, indicate the lines of descent through which the species have passed. The complete study of embryology must, in time, give us much more correct notions of actual relationships than any other line of enquiry; for it is highly probable that the embryonic stages show us, more or less completely, the lines through which the ancestral form has been developed, to produce the present condition of its offspring. It is to embryology, therefore, that we must look to furnish the clues to the true relationships which exist between animals, and a true genealogical classification can only be formulated by the aid of the knowledge which it contributes. We aim at obtaining a "natural" system of classification of insects, *i.e.*, an indication of the line of descent of the various species we study, and their connection with each other, and, hence, for this purpose, the structure of the embryo is often of more importance than that of the adult. Darwin says:—"In two or more groups of animals, however much they may differ from each other in structure and habits in their adult condition, if they pass through closely similar embryonic stages, we may feel assured that all are descended from one parent form, and are, therefore, closely related. Thus, community in embryonic structure reveals community of descent; but dissimilarity in embryonic development does not prove discommunity of descent, for, in one of two groups, the developmental stages may have been suppressed, or may have been so greatly modified through adaptation to new habits of life, as to be no longer recognisable. Even in groups in which the adults have been modified to an extreme degree, community of origin is often revealed by the structure of the larvæ. . . . . As the embryo often shows us, more or less plainly, the structure of the less modified and ancient progenitor of the group, we can see why ancient and extinct forms so often resemble, in their adult state, the embryos of existing species of the same classes. . . . . Embryology rises greatly in interest, when we look at the embryo as a picture, more or less obscured, of the progenitor, either in its adult or larval state, of all the members of the same great class."

We may now look briefly at the embryonic life of a lepidopterous insect from the time of the fertilisation of the ovum, until the larva hatches from the egg. This can only be done by the aid of a microscope. A very simple instrument with two lenses, a $\frac{2}{3}$ and $\frac{1}{6}$, is sufficient for ordinary purposes, although, of course, many other accessories are exceedingly useful.

To get eggs for this purpose, take an ordinary glass tube and enclose a few females of some common Tortricid moth. These moths will usually lay their eggs on the glass, and their eggshells are so transparent that the changes may be readily observed. Among the butterflies, eggs of *Pararge megaera* and *Nemeobius lucina* are not at all unsuitable for observation.

It is sometimes inconvenient to study the embryological changes which go on in an egg under a microscope, at the time that they actually occur. Two very good methods have been described in detail, by which the eggs may be killed and preserved for future observation. One of these is the distribution of the eggs in phials, one phial to be filled with carbolic acid, an egg put in, and the phial stoppered on each day, until the final one contains the newly-hatched larva. The other is to kill by heating in water at 80° C., then puncture the eggs with a fine needle, and stain with "Grenachar's borax carmine" or "Czochar's cochineal."

It is an established fact of science, that every living being is evolved from a single unicellular germ. The egg in insects is not the earliest condition of the creature, because the primitive ovule can be traced back to the ovariole, or even to the primitive ovary, before the ovariole is developed. There is no need here to enter into the development of an ovum from the primitive ovary, as it is fully described elsewhere.* Suffice it to say, that the ovum at last is formed in the egg-chamber, and consists of a mass of yelk surrounded and embedded in protoplasm, and containing the female pronucleus, whilst at the time that the egg is laid, the main mass of it is made up of yelk-spherules. These spherules become granular, and the granules gradually replace the spherules, and are themselves again changed into yelk-cells, the probability being that they are thus changed in order to form suitable nourishment for the young embryo. At this time, the newly-formed blastoderm-cells begin to pass towards the circumference, leaving the degenerated yelk-cells in the centre. In addition to these yelk-spherules, the egg contains a homogeneous fluid, which has the ordinary composition of protoplasm, and consists essentially of the chemical elements, carbon, hydrogen, oxygen, nitrogen, sulphur, phosphorus, lime, soda, potash, and other substances in minute proportions. The great characteristic of this protoplasmic

---

* *Entom. Record*, vol. v., p. 212.

fluid is its vitality, its ability to break up and sub-divide, to develop cellular structure, and to build up tissue from the cells produced by cell-division. After fertilisation, the protoplasmic fluid inside the ovum remains in a homogeneous condition for a certain time; this varies for different species, but is comparatively constant in the same species. The first change that the protoplasm undergoes is that of the ordinary yelk segmentation, but, once this is set up, development continues generally with more or less rapidity. The segmentation starts at a point on the surface of the yelk called the "first segmentation nucleus," and this nucleus undergoes cell-division in such a manner, as to form a superficial blastodermic layer. Side by side with this process of segmentation, the yelk separates from the outside cell-wall, and appears to become enveloped in a sac. The blastoderm layer (or layer of segmentation cells) has an elongated ventral plate formed in it, and in this the development of the embryo commences. This ventral plate broadens anteriorly, but the posterior part is divided transversely into segments. This development is at once followed up by the formation of a longitudinal depression, the outer sac gradually enclosing this depression on either side, until, at last, the opposite sides of the epiblast, or outside layer of cells undergoing segmentation, unite over the depression, leaving it as a longitudinal tube. This becomes detached as a solid cellular mass, which splits into two longitudinal (mesoblastic) bands. At this period it would appear that the amnion is formed.

Of this, Osborne says: "After the yelk has become surrounded by the growth of cells called the blastoderm, and, after the germinal stripe, or foundation of the embryo, has been differentiated along one side of this blastoderm, a double fold of the latter grows up all round the circumference of the germinal stripe, and finally closes in over it, the edges of the fold fixing together, and the two layers (of blastoderm) of which it is composed, at the same time separating from one another. The inner of these, continuous with the embryo itself, and lying immediately over it, is the amnion; the outer, continuous with the blastoderm surrounding the yelk, is the serous membrane. Two sacs are thus formed, the one within the other, and between them lies the yelk. In the lepidopterous egg, the yelk next finds its way into the space between the amnion and the serous membrane, flowing over the former and depressing it and the embryo beneath it, till both are completely submerged in yelk, and consequently hidden from view."

After this the mesoblastic bands become divided into somites, and the first traces of the abdominal segments may be noticed, followed by the appearance of the three thoracic segments. The somites coalesce, and the common body-cavity thus enclosed, is called the cœlom. The three thoracic segments bear legs. The head, which appears to be formed of four segments, and the eye-spots, of which there are two clusters (each made up of six ocelli), placed one on either side of the second segment of the head, reckoning from the front, are then developed, followed in turn by the ventral prolegs. The inner part of the hypoblast is absorbed to form the alimentary canal. The cells, now contained between the outside wall of the egg and the newly-formed alimentary canal, divide up into clusters, which are gradually differentiated into the various internal organs. The first of these to be formed is the dorsal vessel, which is so called because it is placed in the dorsal part of the larva; this corresponds with the heart of the higher animals. The other organs gradually undergo differentiation, and the mouth organs also become developed. At this period of development faint pulsations of the dorsal vessel are discernible. The separation of the alimentary canal into an œsophagus, a widened sac or stomach, and another contracted tube or intestine is clearly discernible, whilst the outer proteid part of the egg-contents is probably absorbed by cutaneous endosmosis. The tracheæ are developed from the spiracles inwards, but do not become visible until injected with air.

Such are the broad outlines of the larval development within the egg. From a tiny mass of protoplasm in the yelk of the egg, we get a larva produced such as we know it when newly-hatched. The egg-shell of most of our larger species is too opaque to allow these changes to be seen, but they can be readily observed, as we have already stated, in the eggs of Tortricids or Pyralids, owing to the thinness of the walls of the eggs in these groups.

During the first stages of embryonic development, the ventral side of the embryo is external, or lies along the inner concave side of the egg, development commencing (as is usual in the Articulata and Vertebrata) on the ventral side of the insect. As development proceeds, the embryo changes its position, on account of the turning of the anal segment and its gradual upward movement, and that of the growing segments behind it, along the venter. In this manner the ventral part of the embryo gets turned towards the centre of the egg, whilst the dorsal part is turned towards the outside.

Our observations of these movements were made on the embryo of *Peronea* (*Tortrix*) *ferrugana*. We found that when the embryo begins to show traces of segmentation, the thoracic segments are seen to develop three pairs of jointed buds or legs. At this time the embryo occupies a somewhat curved position, with the head slightly bent round towards the anal extremity, but with the legs outside, *i.e.*, the larva is bent back on itself so as to form a curve agreeing roughly with the curvature of the shell, with what afterwards becomes the ventral surface of the larva outside, and the dorsum towards the centre. The embryo then gradually changes its position, the anal segment curling round and being pushed by the growth of the preceding abdominal segments, slowly up the ventral surface of the larva; whilst the dorsum gets pushed out, as it were, towards the centre of the egg. During this process the embryo becomes shaped something like the letter S, the movement continuing until a complete reversal of the embryo has been effected. The next stage is that in which the head and anus are in contact, each half running almost parallel, and this again is followed by an almost circular position, in which the dorsal area is now outside, and the ventral surface (with the legs) on the inside. The head, during all this time, scarcely changes its position. Very little further change in position takes place, the embryo, by this time, occupying all the available space in the egg.

With regard to the change in position that the embryo undergoes in the egg, Chapman says that at the time that the ventral surface is towards the margin of the egg, the dorsal surface, or rather dorsal aspect, is still applied to the yelk-sac. At this time the dorsal surface is still broken by the umbilical opening, but, when the latter closes, the young larva is truly a larva, possessing no organic connection with the other egg structures, and may no longer be regarded as an appendage to the yelk-sac. The first use it makes of this liberty is to assume the S or pot-hook shape, continuing until at length its position is reversed, the dorsum being along the circumference of the egg and the venter being central. The head and tail sometimes merely meet (in the flattest eggs), sometimes slightly overlap, whilst in the dome-shaped eggs, the head so overlaps as to take, very often, a central position in the vertex of the egg, forming a dark spot there, as in *Acronycta*, *Callimorpha*, Hesperids, and many others. The essential importance of this observation is that it shows that the embryonic position of the nervous system is the same in insects as in vertebrates, and since it must, therefore, be identical also in the mature animal, it follows that the venter of insects corresponds, anatomically, with the dorsum of vertebrates and *vice versâ*. Another important point with regard to this movement is, that whilst the larva is still truly an embryo, *i.e.*, attached to the yelk and egg-structures, it has the venter outwards, but when the embryo becomes free, it moves as it likes, although this particular movement goes on so slowly, and without any apparent voluntary or even muscular effort, that it appears to be due to the mere force of the growth and development of the larva.

During all this time, the disappearance of yelk has been taking place, but just when the embryo has attained its full growth, voluntary efforts to swallow are apparent, and the remainder of the yelk disappears. The remaining fluid is either absorbed by the larva through the skin, or evaporates through the shell; the tracheæ become visible by becoming filled with air, and the larva usually begins soon afterwards to commence eating its way through the shell.

It would appear from Jeffrey's observations* that the tracheæ come rather suddenly into view, at the time that they are first distended with air. He states that "the filling of the tracheæ commenced in the posterior segments, a sort of cloud gathering at the band where it is close to the head and in a line with the eye." He says: "I saw an apparently dark flood start from this spot, and, creeping along with a spasmodic effort, filling the branches, in its course, till it reached the head, and the whole of the tracheæ became conspicuously visible on that side of the body."

The same observer describes how the dorsal vessel (heart) became visible in an embryonic *Botys hyalinalis*, on the tenth day after incubation. The pulsations were at first (8 a.m.) very faint and feeble, taking place somewhat irregularly at long intervals of 20 and even 30 seconds; but, after a few hours, they became more distinct, with shorter intervals between each beat, and became still more accelerated by the evening of the same day. Two days afterwards, a beautifully clear view of the heart and its action was obtained, the pulsations being timed at 40 per minute, increasing to 60 a few minutes before the larva escaped from the egg.

The important part played by the blood-tissue in larval nutrition, together with the supposition, entertained for many years by certain eminent naturalists, that circulation of the blood did not take place in

---

* *Ent. Mo. Mag.*, vols. xxii. and xxiii.

insects, has led to considerable discussion. The origin of the "blood-tissue" was worked out at length by Graber,* who concludes that the whole of the structures forming this "tissue," *viz.*, oenocytes (certain cell-masses), fat-body and blood-corpuscles, are ectodermic structures. He further finds that the oenocytes are metamorphosed into the fat-body, and that the blood corpuscles arise from the fat-body, and, probably, also directly from the oenocytes. Wheeler,† however, looks upon the fat-body as a thickened part of the inner coelomic wall, due to an accumulation of fat-vacuoles in the cytoplasm of the mesoderm-cells." He further concludes that the fat-body is not derived from the oenocytes, is of mesodermal, not ectodermal, origin, and concludes that there is no evidence for the origin of the blood from the oenocytes. Wheeler also remarks that—"Few insects appear to be better adapted for tracing out the origin of the oenocytes than the Lepidoptera. This is especially true of the larger Bombycid moths. That the segmental cell-clusters arise by delamination from the ectoderm was conclusively made out in the embryos of *Platysamia cecropia* and *Telea polyphemus*. Each cluster is several cell-layers in thickness, and lies just behind, and a little ventral to, an abdominal stigma. The succulent cells constituting the cluster are at first polygonal from mutual pressure, but, as the time for hatching approaches, they become rounder and more loosely united. I have not traced them through the larval stages, and merely record these fragmentary observations because they completely confirm Tichomiroff's and Graber's observation on the origin of the oenocytes from the ectoderm."

The study of the lepidopterous embryo has given us many other interesting morphological particulars. Kowalewski found ten abdominal somites in the embryo of *Smerinthus populi*, all bearing prolegs; whilst Tichomiroff detected eleven abdominal somites in the embryo of *Bombyx mori*, all provided with prolegs except the first. Graber also found the abdomen of the lepidopterous embryo to consist of eleven true segments, and observed that the abdominal segments of *Eutricha* (*Gastropacha*) *quercifolia* were at first devoid of appendages, and that, when they did appear, they developed only on those segments on which they persist in the adult.

The mode in which the earliest development of the generative organs in the embryo of insects takes place is very obscure, but it would appear that the primitive ovaries are composed of a mass of cells, produced by an infolding of the ectoderm. Some writers, however, consider them to be derived from the mesoderm, whilst others trace their origin back to certain so-called pole cells, which originate even before the blastoderm is formed. However this may be, it would appear that they are, in that early stage, quite indistinguishable from the other blastoderm cells. As development proceeds, the great mass of cells become differentiated into various structures, which subserve a special purpose, or perform a certain function. Certain cells in the ovary, however, retain their primitive condition, and, with it, the power, under suitable conditions, of forming another individual of the same species. On this subject, Woodworth writes: "About the time of the completion of the blastoderm, the already differentiated ventral plate infolds at a point on the median line about two-thirds from the upper end, and forms a very narrow pocket. The cells composing it look like the rest of the cells of the ventral plate at this time; they are almost round, and have a lining on one side, made of the grey matter which originally bordered the whole egg, but which became a part of the blastoderm cells. The pocket remains open but a short time, but there is a long depression at the upper end of the bunch of cells. The mass of cells is soon cut off from the ventral plate, and they are then free in the body cavity, but remain in contact with the ventral plate at the point where they were produced. Later stages show that these cells produce the generative organs. The generative organs thus appear to be produced by an infolding of the ectoderm, or possibly of the blastoderm, before the ectoderm is produced, but from a portion which is later to become ectoderm. The general idea has been that the generative organs in insects are produced from the mesoderm, although Metschnikow, as early as 1866, showed for certain insects a different origin."

---

* "Ueber die embryonale Anlage des Blut- und Fett-gewebes der Insekten," *Biol. Centralbl.*, Bd. ii., Nos. 7-8, pp., 212-224.

† *Psyche*, vol. vi., p. 255 *et. seq.*

Those further interested in the details of this subject would do well to refer to the writer's chapter on the "Embryology of a lepidopterous insect," *Ent. Record*, vol. v., 1895.

CHAPTER IV.

PARTHENOGENESIS OR AGAMOGENESIS IN LEPIDOPTERA.

It is generally necessary, among the Lepidoptera, that the two generative elements should unite before the fertilisation of the ovum can take place, and, since these elements are always developed in different individuals, it follows that copulation between the sexes is necessary for fertilisation, and for the subsequent production of young. It appears, however, that under certain conditions copulation is not necessary to ensure the production of young, since, occasionally, eggs will produce larvæ without the union of the sexes, and larvæ thus produced have been recorded as developing in the ordinary course into fully matured and fertile imagines.

It is a well-known fact that, under ordinary circumstances, the eggs of almost all lepidopterous insects undergo certain changes after being laid. Some of these are common both to fertilised and unfertilised eggs, and since they must be looked upon as the outward sign of a change that is taking place within the egg, it is probable that the first changes which take place in the egg, *i.e.*, the very first stages of embryonic growth, are independent of fertilisation. The changes which take place in the unfertilised eggs of some species are much greater than those which take place in others, and there are, as previously stated, cases on record in which development has proceeded so far, that the growth of the embryo has been completed, and a larva has hatched from the unfertilised egg.

We see, then, that, under special conditions, nature produces progeny from virgin females without the intervention of the male. The production of such progeny among bees has long been known.

Virgil refers to it in the *Georgics*, and the old authors termed the phenomenon, "Lucina sine concubitu." It is now known as "agamogenesis" or "parthenogenesis." It must be confessed that scientific experiments, conducted with sufficient care, relating to this subject, have been rarely performed, and that the evidence rests largely on chance observations. Still, there can be no doubt that some of the experiments, at least, have been sufficiently accurate to necessitate a scientific explanation of the phenomenon.

It would be out of place here to discuss the general question of reproduction in the lower Invertebrates, a brief summary of which may be found, *Entom. Record.*, v., pp. 219 *et seq.* It need only be mentioned that fission or cleavage, gemmation or budding, and encystation are the more general means by which it is effected. In the Hydrozoa, reproduction is carried on all the summer by gemmation, but in the autumn, sperm cells and germ cells are produced in the same individual, the former fertilising the latter, which then become ova, in which stage these creatures pass the winter. This method of sexual reproduction (*i.e.*, with both sexes in the same individual) is very common in the lower animals, but among the higher invertebrates the sexes are usually differentiated in separate individuals, and, as a rule, coition is necessary for reproduction. This is the ordinary condition among insects.

Among the Crustacea such species as *Polyphemus oculus*, *Apus cancriformis* and *Limnadia gigas* consist, Newman says, almost entirely of female individuals, the presence of a male being the exception. *Daphnia* has males as well as females, but, according to Lubbock, the females appear equally prolific in the absence of the males. Newman also states that in some Arachnids the fertility of the female is not dependent on coition with the male. He instances *Epeira diadema*, which he states invariably produced fertile eggs without union with a male.

Among insects, the agamic reproduction of Aphides has long been well understood. This, however, is rather different from the parthenogenetic phenomenon presented by Lepidoptera, Hymenoptera, etc. In the former, viviparous young are produced by the females; in the latter, eggs are laid, and produce larvæ in due course, without the usual intervention of the spermatozoa.

Most of the records of the occurrence of parthenogenesis in Lepidoptera are, from a scientific point of view, most unsatisfactory, and based on chance observation, rather than on specially devised experiments. This is, perhaps, due to the fact that those entomologists who inbreed insects in the largest numbers, do so in order to obtain fine specimens for collections, and, as a matter of course, pair the females with males in order to ensure the due fertilisation of the eggs. It must also be borne in mind that, so far as our observations have gone, those species that show a parthenogenetic tendency, only lay a very few eggs in an occasional batch, that will produce parthenogenetic young. A very large number of female moths, therefore, would have to be sacrificed in order to obtain a very small number of parthenogenetically fertile eggs. This does not apply, however, to the Psychids, where parthenogenesis, in some species, appears to be the rule rather than the exception.

This has been clearly shown by Jourdan in the case of *Bombyx* *mori* (*Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences*, Paris, liii., 1861, pp. 1093-1096), where he remarks that it has long been customary, in the silk-producing countries of France, to regenerate a worn-out race by using "la graine vierge," *i.e.*, eggs produced from females that have not been paired with males. He details certain experiments made in 1851, which show the proportion of female moths that give fertile eggs parthenogenetically. From these experiments we learn that he had 300 yellow Milanese cocoons of a form of *B. mori*, that gives only one generation per year. The results work out as follows:—June, 1851—300 cocoons selected, each cocoon placed in a small cardboard box covered with gauze, so as to completely imprison the moth on emergence. The 300 cocoons produced 147 females and 151 males. The boxes containing males were removed and the females carefully preserved without being uncovered. Of the 147 females, six gave fertile eggs. Two gave 7 eggs each, two others 4 eggs each, one gave 5 eggs, and one 2 eggs. These 29 eggs, preserved in their respective boxes without being uncovered, to render error impossible, hatched May, 1852. Many other eggs, it is mentioned, passed from the pale yellow (colour when newly-laid) to the slaty-grey hue, which replaces the former after some days in fertile eggs. The summarised results of this experiment worked out at:—147 females, laid about 58,000 eggs, of which 29 produced larvæ, *i.e.*, about 1 : 2,000.

Another experiment was made by Jourdan, in July, 1851, on white cocoons from South China, of a form of *B. mori*, giving five or six successive generations in one year. Fifty cocoons were separately isolated, as in the last experiment. From these emerged 23 females and 26 males. Seventeen of these females gave completely fertile eggs. One gave 113, and the least productive 12. The total number of eggs laid was 9,000, of which 520 produced larvæ. This gives a proportion of 1 : 17. They hatched seventeen days after being laid.

Although these experiments proved conclusively that some virgin females of *B. mori* could reproduce their kind without copulation, it was evident from the results, that the parthenogenetic reproductive power was exceedingly feeble. Of the two different races experimented upon, that with five or six successive generations per year was much more productive, parthenogenetically, than that with a single generation.

One of the earliest essays on this subject was that of Von Siebold (translated by Dallas), entitled: *On a true parthenogenesis in moths and bees*. Siebold was led into his enquiries by some observations made on the reproduction of a species of Psychid moth, which, he noticed, propagated without copulation. He followed this up with observations on bees and *B. mori*, and found that the phenomenon of reproduction by virgin females was not at all uncommon. For this, he adopted the term "parthenogenesis," which had previously been applied by Owen to the phenomenon now known as "alternation of generations."

According to Siebold, we learn that the oldest communication relative to reproduction by female insects, *sine concubitu*, was made by Albrecht of Hildesheim, who (in 1701) relates that he found a brown pupa in a cocoon on a black-currant bush, and preserved it to see what moth would emerge from it. At the end of July, a moth of yellowish-white colour was disclosed, and in a few days laid a great number of eggs, and then died. In April of the following year, Albrecht was astonished to find young black caterpillars in the box, instead of the eggs. His communication to the Leopoldine Academy of Naturalists shows that he was satisfied that copulation had not taken place. In 1772, Bernoulli recorded that Baster had obtained fertile eggs from an isolated female of *Gastropacha quercifolia*, that had been bred from a caterpillar; and further, that a caterpillar of *Episema* (*Diloba*) *caeruleocephala*, having changed to a pupa, the latter was left in a closed box, and that, about fifteen days after, he was surprised, on opening the box, to find, besides the enclosed moth, a family of young caterpillars, which had already devoured the pupa-case of their mother, and a portion of their own egg-shells. Denis and Schiffermüller pointed out, in 1776 (*Syst. Verz. der Schmett. der Wiener Gegend*, etc., p. 293) that these cases were possibly errors of observation; whilst Von Scheven considered that the larvæ were probably from eggs laid by another female moth, previously confined in the same box.

Siebold, being very dissatisfied with what was known about the subject, turned his attention to the "case-bearers," *Solenobia lichenella* and *S. triquetrella*, and during the years 1850-1852 (the date of Jourdan's experiments on *B. mori*) he collected several hundred cases. None but females emerged from these cases, and they commenced almost immediately to lay eggs. They "possessed such a violent impulse to lay their eggs, that, when I removed them from their cases. . . . . they let their eggs fall openly. If I had wondered at the zeal for oviposition in these husbandless *Solenobia*, how was I astonished when all the eggs of these females, of whose virgin state I was most positively convinced, gave birth to young caterpillars, which looked about with the greatest assiduity in search of materials for the manufacture of little cases!" Parthenogenetic reproduction in *Solenobia lichenella* had also been observed by Wocke and Reutti. For many years the female of *Apterona crenulella* (*Psyche helix*) only was known,* and Siebold, to make sure that none of the "wingless and footless moths" were males, dissected many. He satisfied himself that all were females, and their unfertilised eggs were found to develop larvæ in the same year.

In 1795, Constans de Castellet, general inspector of the silk industry in Sardinia, had reported to Réaumur that he had reared caterpillars from unfertilised eggs of *Bombyx mori*. "Ex nihilo nihil fit," was Réaumur's sceptical reply. Herold, in 1838, reported that amongst the unfertilised eggs of *B. mori*, some here and there passed wholly or partially through the same changes as fertilised eggs, although they failed to hatch, and he distinguishes (*Dis. de anim. vert. caren. in ovo formatione*, Fasc. ii., 1838, Tab. 7, fig. 31) between the fœtus developed from fecundated, and that developed from unfecundated eggs, the former escaping as a larva, whilst the latter perishes in the egg-shell. He distinguished readily, also, various degrees of the faculty of development of unfertilised eggs, which manifested themselves by infinite differences in the disposition, number, form, and strength of the coloured portions of the egg. Herold was able to extract a fœtus from one of these unfertilised eggs in the middle of winter. According to Herold, embryos were not developed in all the unfertilised eggs examined, nor did he know of any case in which such embryos emerged from the egg. As far back as 1669, it may be mentioned that Malpighi was well acquainted (*Marc. Malp. Diss. de Bombyce*, Lond., p. 82) with these differences. He also then knew that the eggs of Lepidoptera were not fertilised at the time of copulation, but that each one was afterwards fertilised separately.

---

* The male of *Apterona crenulella* (*Psyche helix*) was re-discovered by Clauss. He described and figured the larval case of the male, the difference between the pupæ of the sexes, and the male imago in *Zeits. Weiss. Zool.*, xvii., p. 470. Until then it does not seem to have been noticed since the time of Réaumur.

Siebold quotes, on the authority of Filippi, that Curtis had received an isolated chrysalis of *Telea polyphemus* from America, from which a female emerged, all of whose eggs developed, adding that he believed a similar occurrence sometimes took place in *B. mori*. Filippi relates that, in 1850, he observed the phenomenon in that variety of the latter species known as *trevotini*, which has three broods in a year. He also states that Griseri had also observed that many eggs of virgin females of *B. mori* developed. Siebold observes that various silkworm breeders in Breslau and Munich gave him similar information, and that he himself noticed exactly the same well-known change of colour, which took place in the fertilised eggs of this species, occurring in a large number of unfertilised eggs, although many stopped at various stages, only becoming reddish or violet, whilst only a very few went through the entire series of colour-change to slaty-grey. Siebold obtained no larvæ from them, but, in 1854, he received unfertilised eggs from Schmid, which produced larvæ. He tells us that he expected to breed only males, due to his having read Lacordaire's account of Carlier's observations, that "he obtained, without copulation, three generations of *Porthetria* (*Liparis*) *dispar*, of which the last gave only males, which naturally brought the experiment to an end." Siebold, however, bred both males and females, which copulated freely, and appeared to have the ordinary amount of vitality. Kipp had previously recorded the rearing of both males and females from some unfecundated eggs of *Smerinthus populi*.

A brief summary of what has been observed in this country (with a few incidental outside observations) may now be useful. Newman in 1856, gave a list of Lepidoptera in which the phenomenon of parthenogenesis had been noticed up to that date. These were :—*Sphinx ligustri*, *Smerinthus populi*, *S. ocellatus*, *Porthetria dispar*, *Psilura monacha*, *Diloba caeruleocephala*, *Telea polyphemus*, *Saturnia pyri*, *S. pavonia*, *Orgyia gonostigma*, *O. antiqua*, *Bombyx mori*, *Lasiocampa quercûs*, *Arctia caia*, *A. villica*, *A. casta*, *Dendrolimus pini*, *Cosmotriche* (*Odonestis*) *potatoria*, *Eutricha* (*Gastropacha*) *quercifolia*, *Sterrhopterix hirsutella* (*Psyche fusca*), *Apterona crenulella* (*Psyche helix*), *Canephora unicolor* (*Psyche graminella*), *Fumea casta* (*Psyche nitidella*), *Solenobia triquetrella*, *S. clathrella*, *S. lichenella*.

The observations on which this list were based are sometimes of a very unsatisfactory nature, but others are more convincing, *e.g.*, Tardy's experiments with *L. quercûs*, in which three generations of perfectly vigorous and full-sized moths were reared without a single coition having taken place. Mory of Basle (*Ent. Rec.*, vi., p. 209) recently obtained larvæ from unfertilised eggs of this species. A note in the *Ent. Weekly Int.*, iii., pp. 175-176, states that parthenogenetic females of *Solenobia inconspicuella* had been bred, whilst in the *Ent. Rec.*, vi., p. 89, Freer records the rearing of *Talaeporia pseudobombycella* parthenogenetically. Douglas (*Substitute*, p. 78) states that he has bred

Fumea nitidella from what he believed to be unfertilised eggs; the evidence, however, is here very unsatisfactory. Newman *(Entom.*, ii., p. 28) records larvæ from unfecundated eggs laid by a female *Phigalia pedaria*. These in due time became pupæ, but no imagines were reared. Eaton (*Entom.*, iii., p. 104) records an instance in which parthenogenetic progeny of *Orgyia antiqua* were reared to the third generation. The details are:—*First generation*.—From a pupa found at Venn Hall, Sherborne, Dorset, in the autumn of 1864, a female imago emerged, which laid eggs. *Second generation*.—Of the above-mentioned eggs, ten hatched in the spring of 1865, but of these larvæ, one only, the largest from the first. came to maturity; this produced a female which laid eggs. *Third generation*.—Five larvæ from these eggs attained the pupal state of development, and one of them produced a female imago by the middle of October. No further details are given.

It may now be well to summarise some of the records under the various families to which the species belong:—SOLENOBIIDES.—*Solenobia inconspicuella*, *vide Ent. Rec.*, vol. vi., p. 5, where it is stated that parthenogenesis in this species is well known. *S. clathrella*, mentioned by Newman in *Phys. Characters in Classif.*, 1856. *S. lichenella*, Wocke and Reutti (*teste* Siebold). *S. triquetrella*, Siebold's experiments on this species. and *S. lichenella*, have already been detailed, see *Ent. Rec.*, v., pp. 292-3. *Talaeporia pseudobombycella*, Freer, *Ent. Rec.*, vi., p. 89, very many parthenogenetic larvæ obtained. PSYCHIDES.—*Apterona crenulella (Psyche helix)*, was experimented upon by Siebold, and dissections of the parthenogenetic females were made. At this time, the male of this species was unknown. *Canephora unicolor (Psyche graminella)* and *Sterrhopterix hirsutella (P. fusca)* are both mentioned in Newman's list. *Fumea casta (nitidella)* rests as a parthenogenetic species, on Douglas' unsatisfactory evidence. NOTODONTIDES.—*Diloba caeruleocephala*, Bernoulli, 1772, records the hatching of unfertilised eggs. *Notodonta dictaeoides*. There is a record made by Alderson, as to the probability of this species being parthenogenetic, *Entom. Rec.*, vol. i., p. 96. *Cerura vinula*. Alderson notices unfertilised eggs of this species hatching, *Ent. Rec.*, i., p. 95. LIPARIDES.—*Porthetria dispar*, Carlier (*teste* Lacordaire), records three generations without copulation having taken place. Pearce, *Ent.*, xii., p. 229, obtained larvæ May 6th, 1879, from unfertilised eggs. Weijenbergh, *Archives Néerlandaises*, v., 1870, pp. 258-264, records that fertile eggs of autumn, 1866, hatched April, 1867, and produced imagines, August, 1867; from these, without fecundation, eggs hatched April, 1868, and imagines appeared August, 1868; from these, again, without fecundation, eggs hatched in April, 1869, imagines in August, 1869; from these, without fecundation, eggs did *not* hatch in spring of 1870, but dried up. *Laelia coenosa*. Brown, *Entom.*, v., p. 395, an isolated female emerged, laid more than 50 eggs, which duly hatched and were sent to Hellins. *Orgyia antiqua*. Eaton, *Entom.*, iii, p. 104, data already given. *O. gonostigma* and *Psilura monacha*. Mentioned by Newman, *Essay Phys. Charac.*, etc. ARCTIIDES.—*Arctia caia*, *A. villica* and *A. casta*, are mentioned by Newman in his *Essay Phys. Charac.* *Spilosoma mendica*. Bowell, *Ent. Rec.*, i., p. 174, obtained a batch of ova from female just out of pupa case, of which 15 hatched. NOCTUIDES.—*Anarta myrtilli*. Watson, *Entom.*, xv., pp. 261-2, records putting a pupa in a closed box, that the latter was opened some time after, and contained a female imago and many young larvæ, dead. LASIOCAMPIDES.—*Lasiocampa quercûs.*—Tardy (*teste* Newman) bred three parthenogenetic broods of perfectly vigorous and full-sized moths. Mory of Basle, *Soc. Ent.*, April 1st, 1895, also records many larvæ from unfertilised eggs. *L. trifolii* is recorded by Bouskell, *Trans. Leices. Lit. Soc.*, iv., p. 422, as laying a few unfertilised eggs in 1896, which hatched in the following spring, and shortly afterwards died. *Eutricha* (*Gastropacha*) *quercifolia.* Baster (*teste* Bernoulli) obtained fertile eggs from an isolated bred female, *Cosmotriche* (*Odonestis*) *potatoria* and *Dendrolimus pini*, are both mentioned by Newman in his *Essay Phys. Charac.* BOMBYCIDES.—*Bombyx mori.* Many cases have already been dealt with at length. SATURNIIDES.—*Saturnia pavonia.* Noticed by Newman, *Essay Phys. Charac.*; also by Bouskell, *Trans. Leic. Lit. Soc.*, iv., p. 422, who mentions that a female laid six eggs in her cocoon, she being unable to get out; these all hatched. *S. pyri* is mentioned by Newman, *Essay Phys. Charac.* *Telea polyphemus.* Curtis (*teste* Filippi) obtained fertile eggs from a moth that emerged from a single cocoon in his possession, and that had come from America. SPHINGIDES.—*Smerinthus ocellatus.* Newman, *Essay. Phys. Charac. Class.*; Brown, *Entom.*, v., p. 395; Headly, *Trans. Leices. Lit. Soc.*, iv., p. 421, the latter mentions that of the eggs laid, 75 per cent. hatched. *S. populi.* Kipp (*teste* Siebold) reared both sexes from unfecundated eggs; Newman, *Essay Phys. Charac. Class.*; Bouskell, *Trans. Leices. Lit. Soc.*, iv., p. 421, mentions twenty out of seventy eggs hatching. *S. tiliae.* Brown, *Ent.*, v., p. 395, no data. *Acherontia atropos.* Geddes and Thompson, *Evolution of Sex*, no data given. *Sphinx ligustri.* Newman, *Essay Phys. Charac. in Classif.*; Nix, *Entom.*, iv., p. 323, all eggs hatched in this brood. Clogg, *Entom.*, v., pp. 356-7, fifty eggs hatched out of the brood. GEOMETRIDES.—*Phigalia pedaria.* Newman, *Entom.*, ii., p. 28, records the laying of many eggs by three unfertilised females at end of February, 1864, and states that, on April 17th, the cage was swarming with newly-hatched larvæ. He failed, however, to get imagines.

Although it may safely be assumed that parthenogenesis does occur in Lepidoptera, yet, as we have just said, it must be confessed that the material based on true scientific experiment is not large, and that many careful observations based on the most exact experiments are required. The elucidation of the peculiar phenomena presented, is worth all the patience with which the entomologist must attack this subject, and he would have the reward of knowing that he had helped to make clearer one of the greatest mysteries of insect life.

The phenomenon of parthenogenesis appears to me to be explicable only by supposing that the potency of the male element is handed down generation after generation, and that former fertilisations affect the embryo, independently of the actual union which fertilises the ovum. The male element must be looked upon as possessing, not only a great and direct influence on the development of the eggs immediately fertilised by it, but also on the eggs of successive issues not directly fecundated. That this is probably so, is shown by the fact that the unfertilised egg often undergoes varying conditions of development, short of the actual development of a perfect embryo. This was foreshadowed in our notes on "the ovum," where the variation and change of the colour of the egg are dealt with. In cases of parthenogenesis, the influence must be powerful enough to cause full development, not only for one generation, but for one or more generations beyond the one normally reached, and in this way may be explained the phenomenon that some species, which usually do not multiply without sexual intercourse, occasionally produce parthenogenetic young, even in cases like *Sphinx ligustri*, *Bombyx mori*, etc., where it could scarcely be expected. It is remarkable that, in most orders of insects, the parthenogenetic progeny is usually male, but, in the *Psychidae* among Lepidoptera, helotoky, or the production of parthenogenetic females, alone takes place.

I may mention, in conclusion, that the great difference that exists between parthenogenesis (1) in the Psychids, where it appears to be, in some species, the rule rather than the exception, as it is in some Cynipids and in bees (as regards male eggs), and (2) in all other Lepidoptera, where it is a rare and occasional phenomenon, is somewhat striking and important. This difference, no doubt, is only one of degree, but so great a degree as to be parallel to a difference in kind. It is quite possible, too, by means of the Psychids, to ally the parthenogenesis that takes place in Lepidoptera with that known to occur in the *Cynipidae*, and the phenomena might perhaps be brought into connection with a more primitive method of reproduction, *e.g.*, gemmation. I am quite clear that the *modus operandi* of parthenogenesis in Lepidoptera is still as obscure as ever, and that the explanation I have offered does not help matters much. It, however, is the only logical explanation that has occurred to me, and must be taken for, and only for, what it is worth.

CHAPTER V.

THE EXTERNAL STRUCTURE OF THE LEPIDOPTEROUS LARVA.

At the time that the lepidopterous larva escapes from the egg, it possesses true insect characters. Its body is composed of a series of segments, containing the muscular, digestive, circulatory, respiratory, and nervous systems. It breathes by means of tracheæ, a series of fine tubes composed of an elastic membrane, and kept open by a spiral structure, which passes throughout their whole length. The four segments of the head are now welded into an almost inseparable whole, and, although the first three body-segments are assigned to the thorax, there is no well-marked separation between the thoracic and abdominal regions. The skin of the newly-hatched larva is very soft, but it quickly becomes harder, owing to the solidification of the horny substance called chitin in the outer cuticle. Usually larvæ have a somewhat colourless skin when just out of the egg; but the hardening of the cuticle is frequently accompanied by the production of a difference in colour, and by the development of the distinct markings which are characteristic of the larval cuticle, so that an almost colourless larva may, within an hour of hatching, become almost black. This hardening does not affect the sutures, and the intersegmental membranes allow the segments to move freely upon each other. The body segments are usually sub-divided into subsidiary rings or sub-segments, which also move more or less freely upon each other. The sub-segments are divided again into still smaller solid portions, which have a certain amount of freedom, and are technically called sclerites.

A general description of a typical caterpillar or larva now becomes necessary. We find that the caterpillars of Lepidoptera are usually long and cylindrical, being, however, somewhat flattened on the ventral surface. They may be considered as being composed of a head, thorax and abdomen, as in the imago or perfect insect, although the distinction between thorax and abdomen is not, as previously noted, distinctly marked. The cylindrical shape of the larva depends upon the fact that the larval skin contains fluid under considerable pressure.

The head is a somewhat horny, compact, oval case, and is furnished with a number of appendages about the oral opening. It is made up of four (or more) segments, which, however, are not distinguishable after hatching. On each side of the head are, usually, six simple ocelli, arranged in lunular form on the cheeks. The mouth consists of a labrum, mandibles, maxillæ (with maxillary palpi) and labium (with labial palpi).

The thorax is composed of three segments (those following the head), which are known as the pro-thorax, meso-thorax, and meta-thorax (or post-thorax) respectively. In all larvæ which burrow underground or feed internally, and in many others, which do not, the dorsum of the pro-thorax is protected with a hard, corneous plate, often, indeed, extending to the meso-thorax and meta-thorax. Each of the three thoracic segments bears on the ventral surface a pair of more or less horny legs (the true legs), which have five joints and terminate in a single claw.

The abdomen consists of the last ten segments of the caterpillar's body. They are very similar, in general appearance, to the thoracic segments, but the tubercles, or little chitinous hair-bearing knobs which they carry, are usually somewhat differently arranged, and they never give rise to true legs. Some of the abdominal segments, however, bear on their ventral surface a pair of stout fleshy protuberances, called pro-legs or claspers ; these prolegs are really extensions of the integument, and have, on their free surface, a number of hooks. The number and development of the prolegs, and the arrangement of their terminal hooks vary considerably, different patterns distinguishing the several families, and even genera. Very little use is made of the true legs for purposes of progression, this being accomplished almost entirely by means of the prolegs. The terminal segment of the abdomen is known as the anal segment. On either side of the first thoracic, and of the first eight abdominal segments, is a tiny opening called a spiracle. The spiracles are round, oval, or longitudinal in shape, and are the channels through which respiration is carried on. Regularly placed on certain parts of the body are to be found little chitinous, hair-bearing knobs (sometimes modified into fleshy elevations), which we have already said are called tubercles. These may give rise to single hairs, but sometimes to exceedingly close and dense fascicles. These tubercles are often strikingly modified at each successive ecdysis or change of skin.

The lepidopterous larva, by its active, independent existence, undergoes special modification and development, in order to protect itself from its various enemies. Hence the larvæ of different species assume, by modification, a manifold variety of shapes, and of arrangement of the various external structures—hairs, tubercles, etc. As the most specialised larvæ present, therefore, such wide divergences from the original type from which they have sprung, it becomes necessary for us often to homologise the complex structures which they now bear with the simple structures from which they originated, and to do this a comparison must be instituted with those larvæ which, from the exigencies of their environment, are but little changed from the more ancestral larvæ. The newly-hatched larvæ of many species, which are very specialised in their adult stages, have the specialised structures in a very simple condition, both as to form, structure and arrangement; whilst many boring and case-bearing larvæ are still more simple in the structure and arrangement of the tubercles, hairs and prolegs, which are especially prone to be changed by external conditions. Larvæ which show this simple arrangement of tubercles, hairs and prolegs, are often spoken of as generalised, in contradistinction to those in which the structures are complicated, and which are termed specialised, larvæ. It must not be forgotten, however, that the most generalised of all lepidopterous larvæ must be far in advance of the larvæ of those insects (Orthoptera, etc.), with incomplete metamorphoses. There can be little doubt that insects belonging to these orders, in which the metamorphoses are carried on within the very narrowest limits, and in which the various stages present but little change, *inter se*, are much more ancestral than the insects belonging to those orders in which the metamorphoses are distinct, and in which the various stages bear but little resemblance to each other.

The Lepidoptera which have the most generalised form of larvæ are the Eriocephalids, Micropterygids, Adelids, Tineids, Sesiids, Psychids, Hepialids, Zeuzerids and the Tortricids. A comparison of these with each other, and with larvæ belonging to more specialised super-families, soon gives us a clue as to the lines on which modification has proceeded in the higher groups.

Having glanced at the general structure of a lepidopterous larva, we may deal with a few of the organs in more detail.

The head of a caterpillar is divided into two lateral halves by a suture, which divides, however, in the centre of the face, and leaves between its forked branches a triangular space. This frontal triangle is termed the clypeus, and is very often distinctly and characteristically marked. Just within, and parallel to the central facial suture, is a deeply-grooved furrow, which is the reverse of a ridge that faces internally, and to which the muscles of the head are attached. The true sutural line is but little developed in newly-hatched larvæ. Just below the clypeus is a short inconspicuous piece of chitin, welded to the clypeus. This is very distinct in some butterfly larvæ (*e.g.*, the Papilionids), and is known as the epistoma. To its lower edge, the usually bi-lobed labrum or lip is attached by a fleshy hinge, enabling it to move freely backwards and forwards upon the mandibles. These latter are arranged on either side of the mouth; each consists of a stout, swollen, short, horny, plate, which is broader at the base, and becomes somewhat pointed at the apex, which varies considerably in different species. In some, the apex is chisel-like ; in others, serrated ; in yet others, pointed. Below and behind the mandibles or upper jaws are found the fleshy bases of the maxillæ or lower jaws, each of which bears a short fleshy joint, to which the maxillary palpi are attached. The inner palpus consists usually of only one or two joints, and is inconspicuous; the outer is more conspicuous, and consists of three joints, of which the two outer are somewhat horny and minute. The under surface of the head, lying between the basal portion of the maxillæ, is occupied by the labium or lower lip. The labium bears, near its tip, on each side, a pair of minute two-jointed palpi, which, from their position, are termed the labial palpi ; their basal part is long, and the upper very minute. The apex of the labium is strangely developed into a small horny tube, from a hole in the tip of which the fluid which is secreted, and which ultimately forms silk, is passed, the tube itself being known as the spinneret. In the caterpillar, the antennæ are very small and ill-developed. They consist of a pair of four-jointed organs, one on each side of the face, placed just outside the base of the mandibles. The basal joint of the antennæ is large and fleshy, the remainder being much more slender, and varying somewhat in shape. The third joint usually carries a long bristle. On each cheek are to be seen the six ocelli, placed just above the base of each antenna ; each one looks like a smooth, hemispherical, protuberant wart, and they vary in colour in different species. Five of them form, usually, a somewhat regular curve, and are placed close together, whilst the sixth lies a little further away, often towards the centre of the cheek. As may be expected, the detailed characters of the head-parts vary somewhat in the different super-families of the Lepidoptera, but the general characters hold good.

The head, too, varies greatly as regards the clothing and secondary organs that it bears. It is usually more or less tuberculated, the tubercles bearing hairs, and there can be no doubt that an actual ontogenetic relationship exists between these and the tubercles of the body segments. The head segment nearest to the thorax, which forms the summit of the head, is sometimes ornamented with long pointed chitinous horns, spiny tubercles, ear-like processes, etc., all of which are prolongations of the corneous head structure. These undergo as varied and as different changes at each exuviation as do those of the body segments, in which simple hair-bearing, warty tubercles become developed into most complicated structures as some larvæ approach maturity.

We have already stated that the head is composed of at least four segments. We are so accustomed to look for organs in all animals having a somewhat similar function to analogous parts in our own body, that it is easy to overlook their real morphological significance. There can be no doubt that in insects the mouth proper is a simple hole, and that the mandibles, maxillæ, etc., are simply modified appendages on the various segments of which the head is built up. We may see how the modification has been brought about by a careful study of the limbs of a Crustacean (*e.g.*, a crab or lobster). The mouth-parts, it is clear from such an examination, are undoubtedly limbs, modified first to hold, then to break, and lastly to masticate, the prey. Ideally, the head is made of several segments, each bearing a pair of organs—labrum, mandibles, maxillæ, labium—which are homologous with the true legs.

Scudder draws special attention to the confusion which has arisen among entomologists as to the application of the terms "maxillæ" and "maxillary palpi." He says that "ideally, and sometimes actually, the maxillæ of insects bear three palpi, any one of which may become specially developed and receive the name of maxilla, while the others are termed palpi, thus the organ called maxilla in one group is not always strictly homologous with that which bears that name in another group."

The segments of which the thorax and abdomen are composed are very much like one another, especially in the earlier stages, but they sometimes become considerably modified in size, shape and appearance, as the caterpillar gets older. The segments, both of the thorax and abdomen, are usually more or less distinctly subdivided transversely into sub-segments or annulets. The first thoracic segment is sometimes considerably modified, constricted in Hesperid larvæ so as to form a neck, swollen in the larvæ of Lycænids, Papilionids, and many moths, so that the head is quite retractile. In Papilionid larvæ, also, it bears on its dorsum a forked scent-gland or osmaterium, hidden in a narrow transverse slit when not in use; in the larvæ of butterflies, Notodonts and Noctuids, it frequently bears on its lower surface a remarkable structure, known as the "chin-gland." This is an eversible gland, and one modification of it is found in the syringe of the Dicranurid larvæ. This, the larva of *Cerura vinula* uses as an offensive weapon, ejecting formic acid from it with considerable force. Of the abdominal segments, the last, the anal segment, is the most modified.

The spiracles or stigmata, as we have already seen, are placed in pairs, one spiracle on each side of the first thoracic and first eight abdominal segments. Chapman was the first to discover that they were, occasionally, found in lepidopterous larvæ on the second and third thoracic segments. Packard afterwards discovered the clustered tracheal tubes, belonging to these segments, in a Sphingid larva, and in that of *Platysamia cecropia*, but without any external sign of the spiracles. Scudder found spiracles on the second and third thoracic segments in the young larva of *Pamphila mandan*. The cause of the usual absence of spiracles on the meso- and meta-thorax, is probably due to the fact that, on these segments, the future wings are, during the larval existence, in process of development. Chapman observes (*Ent. Rec.*, ix., p. 219) that, although there is no larval spiracle on the meta-thorax in *Charaxes jasius*, yet, when the larva undergoes its final ecdysis, and becomes a pupa, a tracheal lining is drawn out between the 2nd and 3rd thoracic segments, where the imago has, but the larva has not, a spiracle. Chapman states that, although the casting of a tracheal lining from the 2nd thoracic spiracle had not been observed by him before he saw it in this species, he had inferred that such occurred, because he had seen it many years ago in numerous larval moultings (first, in the large silkworm, *Antheraea yama-mai*), and had also demonstrated the existence of this spiracle in the imagines.

The spiracles are placed laterally, usually, a little below the middle of the sides, in the centre, or a little in front of the centre, of the segments of the abdomen. The pro-thoracic spiracle is placed near the hind margin of the pro-thorax. They are sometimes very distinct, at other times inconspicuous, usually with thickened lips, frequently of an oval shape and with a raised outer margin. The spiracles on the first thoracic and eighth abdominal segments are sometimes larger than those on the other segments. This is supposed to be due to the fact that the air-tubes from these spiracles ramify over a greater area of the body than do those from the others.

The tubes or tracheæ which branch from the spiracles, carry air to almost all parts of the body. The tracheal tube, or atrium, which leads into the body from each spiracle, is provided with a muscular apparatus for excluding foreign bodies, and for the control of the admission of air into the tracheal system. These are, as it were, muscular valves, and Landois describes the mechanism for this purpose as consisting of four principal parts—the bow, the lever, the band, and the muscle. The contraction of the latter, acting on the lever, causes the band and bow to meet and thus to close the passage. When the muscle relaxes, the natural elasticity of the parts causes them to separate again, and thus leave the tracheal tube open. The spiracle, then, leads into the atrium, which passes, by means of a muscular valve, into another chamber or vestibule, which, by means of another valvular arrangement, leads into the tracheal tubes proper. Lowne considers that the vestibule acts as a pump to force air into the tracheæ.

The true legs of insects are prolongations of the body wall, and consist of :—(1) The tarsus (or foot). (2) The tibia (or shank). (3) The femur (or thigh). (4) The trochanter. (5) The coxa (or base). The lepidopterous caterpillar has three pairs of true legs, one pair being attached to each of the thoracic segments. They are five-jointed, the two basal joints being, usually, larger than those which follow; these joints are of a fleshy structure, whilst the three beyond are leathery or horny. The terminal joint is armed with a small, usually curved, simple unguis or claw. Packard states that, besides the terminal claw on the larval foot, there is apparently a second rudimentary one at the base, which he calls a spine-like "tenant hair," and sometimes also flattened lamellate setæ. The use of the claw and tenant-hair, as grappling organs, is quite apparent; the use of the setæ (which may be identical with Chapman's "battledore palpus") is not known.

The prolegs are also extensions of the integument, and consist, usually, of two large, stout, fleshy joints, which are generally retractile within each other and the body-wall. The character of the prolegs is very important, and the arrangement of the hooks which terminate them has recently been shown to have a distinct bearing on the relationships of the various super-families of the Lepidoptera, and to give important clues to their lines of evolution. In butterfly larvæ there is usually to be found on the inner side of the tip of the prolegs a pair of thickened pads, which move laterally. These usually bear a row of minute, but in some instances, very powerful hooks.

The prolegs are found in most lepidopterous larvæ on the third, fourth, fifth, sixth and terminal abdominal segments, the last or anal, pair, passing both downward and backward, and being, sometimes, more plentifully supplied with little hooks than the other prolegs. These hooks are embedded in the skin, and are arranged usually in three rows, of which, however, sometimes only one and sometimes two are developed. The hooks can be apparently extended at will, and the tip of the foot, between the pads, may be so inflated in some butterfly larvæ as to bring the rows of hooks outside, and then the pads can be opened and shut, so that the larva can cling with great tenacity to anything upon which it is resting. Among the moths the arrangement of these hooks appears to follow well-defined, general rules.

Chapman has discovered that the prolegs of the ordinary external-feeding larvæ of the LEPIDOPTERA-HETEROCERA are essentially of two types, which he calls respectively the "Macro," and the Pyraloid or "Micro" type. The former has a series of hooks on the inner side of the ventral prolegs only, and this appears to be characteristic of exposed-feeding larvæ (Sphingids, Bombycids, Nolids, Noctuids and Geometrids). The Anthrocerids (Zygænids), although classed as INCOMPLETÆ, have prolegs of the "Macro" type. The latter (Micro type) has a complete circle of hooks to the ventral prolegs, and appears to be characteristic of concealed-feeders (Pyralids, Phycids, Crambids, Gelechiids, Plutellids, and Œcophorids). The most remarkable prolegs are those of the ERIOCEPHALIDES. In the larvæ of these moths, eight of the abdominal segments bear a pair of minute jointed legs of the same type as the thoracic.

Chapman thinks that he finds some suggestion of the probable development of prolegs and their hooks in the Adelids—*Nematois fasciellus* and *Adela rufimitrella*. In the larvæ of these species there are "series of chitinous points beautifully arranged in rows, like the teeth of a shark, the larger in front, those in each row alternating with those in the next rows, and gradually getting smaller, till they merge in the fifth or sixth row, in the ordinary integumental points. In the ordinary position of each proleg there are two sets of points facing each other along a transverse line. In *Incurvaria muscalella*, the prolegs have two rows of hooks facing each other in this way along a transverse line. In *I.* (*Lampronia*) *capitella*, the young larva has no hooks, but the full-grown larva has hooks placed in a circle, yet with gaps showing that they are still an anterior and posterior set. In the Tortricids, the row of hooks is usually double; that is, there are longer and shorter hooks, but they are always in one perfect row; but, in other families, we find that traces of the multiple row of *Nematois* persists. This is the case in *Hepialus*. In the Sesiids, again, the circle of hooks is flattened antero-posteriorly, and is weak or wanting at the outer and inner ends, showing a relationship to *Incurvaria*. The anal prolegs very rarely have more than the anterior half developed. In *Hepialus* the circle is fairly complete. The Crambids have hooks of alternate size, like the Tortricids. *Crambus* often has three sizes of hooks alternated in one row." Attention is also drawn to the fact that the larvæ of the Hesperids show, in their three rows of hooks, a persistence of Adelid (or, at least, very low) structure, whilst the adult larvæ of the true butterflies have the same structure as the true "Macros."

The same observer finally concludes that "the proleg seems to reach its full development with a complete circle of hooklets. A higher development of the insect is not only accompanied by a fuller development of the inner half of this circle, but also by the degeneration and disappearance of the outer half. This may often be followed out in 'Macros,' usually among the butterflies, where the young larva has 'Pyraloid' prolegs, which often suddenly (at one moult), or more gradually (in two or three), assume, in the full-grown larva, the unilateral 'Macro' type" *(Trans. Ent. Soc. London,* 1893). Prout has noticed that, in the Geometrid genus *Oporabia*, the newly-hatched larva has a complete circle of hooks.

We have already mentioned that the segments which usually bear the prolegs are the third, fourth, fifth, sixth and tenth abdominal. The Geometrids, however, usually have them only on the sixth and tenth abdominal segments. In the early stages of many Noctuid larvæ, we find, however, only the merest traces of prolegs on the third and fourth abdominal segments; these, however, usually develop completely at the later ecdyses. The peculiar method of progression, characteristic of Geometrid larvæ, is due entirely to the absence of the prolegs on the third, fourth and fifth abdominal segments, and those Noctuid larvæ which do not develop prolegs on the third and fourth abdominal segments, until late in life, resemble the Geometrid larvæ in their mode of progression, whilst a whole group of Noctuid moths, which never do develop them, retain the looping habit throughout, and have been called, on this account, by some entomologists, HEMIGEOMETERS.

In some Geometrid larvæ, prolegs appear on other than the abdominal segments normally carrying them. The larva of *Himera pennaria* obtains a pair of ill-developed ones, on the fifth abdominal segment, at the first moult; these persist after the second and third moults and disappear with the fourth moult. In larvæ of *Anisopteryx aescularia*, prolegs are developed on the same segment, but these continue throughout the whole larval existence.

The larva of an American moth, *Lagoa crispata*, described as being like a hairy Limacodid (*Heterogenea*) larva, with the head retracted, the body short, and the legs so rudimentary as to impart a gliding motion to the caterpillar when it moves, has seven pairs of short abdominal prolegs, the second and seventh abdominal segments each bearing a pair of rudimentary prolegs, in addition to those which normally carry them. Burmeister found exactly similar prolegs on the second and seventh abdominal segments of *Chrysopyga undulata*. According to the figures of Kowalewski and Tichomiroff, the embryonic larvæ of *Sphinx* and *Bombyx mori* have, at first, a pair of prolegs on each abdominal segment, but half of these are absorbed again before the larva hatches.

Some very peculiar methods of progression are to be noticed among the larvæ of certain species of lepidoptera, none, however, is more peculiar than that of the Cochliopodids, of which our two British species, *Heterogenea cruciata* (*asella*) and *Apoda avellana* (*testudo*) are very fair representatives. Resting on the upper surface of the leaves of their food-plants, with the body inflated to form a dome-like structure, they look very little like lepidopterous larvæ, and bear, in fact, a strong resemblance to the pupæ of ladybirds (*Coccinellidae*). The almost evanescent character of the prolegs makes progression on the smooth upper surface of a leaf difficult, and Poulton has suggested that the remarkable undulatory movement by which the Cochliopodid larvæ now progress was due originally to the larvæ first walking "with adhesive claspers," that these gradually became shorter and broader, thus yielding increased support by extending the area by means of which they adhered. Finally the claspers, he considers, would be altogether lost, and the whole of the ventral surface, from which they formerly projected, would take part in locomotion. The modification of the prolegs and the method of progression, is, without doubt, designed to enable the larva to move freely over the smooth upper surface of leaves, which it could not well do under ordinary conditions. The sticky condition of the abdominal surface supports this view, but there can be no doubt that they spin some small quantity of silk on which they walk, as do so many other lepidopterous larvæ.

Besides the tubercles, which have fairly fixed positions on the segments, the skin has, scattered more or less regularly over the body, little elevations, resembling, somewhat, a fine pile or covering of minute hairs. This pile is a very common feature in butterfly larvæ, is supported by very minute papillæ, and is generally distributed with considerable regularity, usually in a transverse, though sometimes in a longitudinal, direction. It is, however, occasionally scattered irregularly all over the body. When it is arranged transversely, it is usually somewhat closely related to the subsegmental divisions into which the segments are divided. Bacot says that this pile, which appears something like a clothing of short pointed spines, is very common in lepidopterous larvæ in their first skin, and, in some, is so fine that a one-fourth lens (or even higher power) is required to detect it. The minute spines or hairs are often only visible at a certain angle, or when the edge of the dorsum is silhouetted against a bright background. In some larvæ this coat is lost at the first, or at a subsequent, moult; in others, it persists throughout the whole larval existence, becoming just a trifle coarser at each moult. The larvæ of *Dicycla oo*, *Dianthoecia carpophaga*, and *Taeniocampa pulverulenta (cruda)*, among many others, illustrate this phase of its development. Bacot is of opinion that primitive and secondary hairs are of different origin, the former arising from the primitive setæ or tubercles, the latter from the minute hairs forming the pile just described. He is also of opinion that the bifid shagreen hairs of *Smerinthus*, the dense clothing of short secondary hairs in some Lasiocampids, the short pyramidal granulations of certain Liparids, and the highly specialised secondary hairs of some butterfly larvæ, are evolved from the minute hairs, which in their simplest condition, form the pile above described.

That this pile is found rather generally among larvæ is proved by the following, very incomplete, list furnished by Bacot. ZYGÆNIDES:—*Adscita statices* and *Anthrocera trifolii* (both in first skin). LASIOCAMPIDES: *Trichiura crataegi*. BOMBYCIDES: *Bombyx mori* (very fine). GEOMETRIDES: *Phorodesma smaragdaria* (first stage, skin granular later). PLATYPTERYGIDES: *Drepana cultraria*. NOTODONTIDES: *Leiocampa* (*Pheosia*) *tremula* (*dictaea*), black in first skin, no trace in second, except on horn, *Diloba caeruleocephala* (in first stage), *Odontosia carmelita* (faint traces in third skin), *Phalera bucephala* (in first and second skins, (?) developed into secondary hairs later on). LIPARIDES: *Dasychira fascelina* (in first skin), *Demas coryli* (strong in first, small in second to fourth skins), *Orgyia antiqua* (distinct but fine), *Leucoma salicis* and *Psilura monacha* (in first and second skins), *Porthesia similis*. ARCTIIDES: *Spilosoma lubricipeda* (first to third skins, small), *S. fuliginosa* (first and (?) third skins), *Arctia villica* (first to fourth skins), *Callimorpha dominula* (strongly developed), *Euthemonia russula* (first to fifth skins), *Euchelia jacobaeae* (first skin). NOLIDES: *Nola cucullatella* (in later stages rather granules than prickles). NOCTUIDES:

Acronicta leporina (slightly in first skin), *Cuspidia megacephala* (in fourth skin, very noticeable and long, almost secondary hairs), *Pharetra euphorbiae* var. *myricae* (first to third skins), *Pachnobia leucographa* (weak in first skin, no trace after), *Triphaena pronuba*, *T. comes*, *T. fimbria*, *T. ianthina* (just traceable in first skin, then absent), *Peridroma saucia* and *Agrotis puta* (first skin, very small), *Dianthoecia carpophaga* (to full-grown, very long), *Taeniocampa miniosa* (large and distinct in first skin, only traces after), *T. gracilis* (very fine, black, in first skin, no trace after), *T. pulverulenta* (strongly marked throughout), *Calocampa exoleta* (in first, no trace in fourth, skin), *Aporophyla australis* (absent, or exceedingly fine in first skin), *Calymnia affinis* (strong in first, small in third, skin, no trace later), *Polia chi* (slight traces in first skin), *Dicycla oo* (strongly marked throughout), *Plusia festucae* (present in third skin). PAPILIONIDES: *Zephyrus quercûs* (strong when, and not until, full-fed), *Aglais urticae* (strong, in early stages). Since the observations, on which this list is compiled, were made offhand, and when studying other characters presented by the larvæ, it can be readily understood how common an occurrence is the presence of this pile in lepidopterous larvæ.

Bacot says: Most of the Noctuids lose the character very early, yet in some it persists strongly throughout the larval life. *Dianthoecia carpophaga* exhibits it from the youngest to adult stage, yet adult *D. cucubali* shows no trace of it. *T. pulverulenta* retains, but *T. miniosa* soon loses, it.

Scudder believes that "the use of this clothing is tolerably clear, since this pile must prevent the too rapid evaporation of the heat from the surface of the body, for, although caterpillars are classed among the cold-blooded animals, they, nevertheless, have an internal heat above that of the surrounding atmosphere, which originates from the activities of the organs and the respiratory functions, and which they would lose more rapidly but for this investing pile."

On the dorsum of the thoracic (and more rarely the abdominal) segments of the larva, a hard chitinous shield is found. This is particularly noticeable in all wood-boring larvæ, such as those of the Cossids, Hepialids and Sesiids, as well as in Crambids, Tortricids, and many Noctuids and Tineids. It is, however, more general and most marked on the pro-thorax, and hence it is often spoken of as the prothoracic shield. Since this structure is equally well-developed in the larvæ of the *Cerambycidae* and other Coleopterous larvæ which also bore into hard substances, it appears probable that this hard chitinous plate serves to protect the head, and parts of the body underlying the shield, from injury. Its appearance, too, in larvæ belonging not only to different families of the Lepidoptera, but also to different orders, suggests that it has been developed in response to the external stimulus supplied by continual friction, an excess of chitin having been deposited (or developed) by the hypodermal cells of the tergal arch of the prothoracic segment. It is not unusual to find the shield, in some form of decadence, in larvæ which now feed fully exposed, especially in certain Noctuids, and occasionally the shield is present in the first larval stage, but lost in the later ones. These occurrences generally take place in larvæ some of whose allies have, or had, boring habits. The value of this shield to boring larvæ for leverage purposes must also be very great, since it gives a solid fulcrum for the head. The excessive development of the dorsum of the pro-thorax in the larva of *Cerura* appears to have no phylogenetic significance, nor any close connection with the chitinous pro-thoracic shields of boring larvæ. It is certainly smooth and shining, but appears to have been modified independently, for protective purposes, in this particular genus. Still, its probable use for the moulding of its hard cocoon must not be altogether overlooked.

The anal segment has caused much discussion as to its structure and homologies, especially with regard to the suranal plate, the infra-anal lobe, the paranal lobes and the paranal tubercles. The supra-anal, or "suranal," plate of Packard, is the "podex" of Kirby and Spence, and both in its shape and ornamentation would appear, especially in Bombycid and Geometrid larvæ, to afford specific characters. It varies much, also, among the Notodonts and Saturniids, and is especially well-developed in those larvæ which constantly use the anal legs for grasping, while the front part of the body is more or less raised. It appears to be correlated with enlarged anal prolegs. According to Packard, this plate, morphologically, appears to "represent the dorsal arch of the tenth or last abdominal segment of the body, and is the 'anal operculum' or 'lamina supra-analis' of different authors. This suranal plate is, in the *Platyptericidae* remarkably elongated, forming an approach to a flagellum-like terrifying appendage, and, in the larva of *Aglia tau*, forms a long, prominent, sharp spine. Its shape, also, in *Cerura* caterpillars, is rather unusual, being long and narrow. In the *Ceratocampidae*, especially in *Anisota*, *Dryocampa*, *Eacles* and *Citheronia*, this plate is very large, the surface and edges being rough and tuberculated, while it seems to attain its maximum in *Sphingicampa*, being triangular, and ending in a bifid point" (*Bombycine Moths*, p. 25).

The "paranal lobes" are the "homologues of the two anal valves observed in the cockroach, and occur in all, or nearly all, insects," according to the same author. They are the "valvulæ" of Burmeister, and the "podical plates" of Huxley. They are fleshy and papilliform in Geometrid larvæ, and appear as if projecting backward from the base of the anal legs. In the larvæ of the Dicranurids they are similar, and each ends in a seta.

The "paranal forks" or "paranal tubercles" are two bristles arising from the end of a papilla, directed backward. They are found in the larvæ of most arboreal caterpillars, being especially well-developed in those of Notodonts and many Geometrids, whilst they are wanting in the larvæ of Noctuids, Sphingids, Rhopalocera (?), and some Geometrids and INCOMPLETÆ (Micro-lepidoptera). In the American *Choerodes*, they are very large; so also are they in the larva of our common *Uropteryx sambucaria*, where they become papilliform and setiferous. Their use was discovered by Hellins. In his description of the larva of *Cerura bifida*, he writes of them :—"At the tip of the anal flap are two sharp points, and another pair underneath, which are used to throw the pellets of frass to a distance." Packard has seen the frass pellets held by the two spines of the paranal tubercles in *Cerura borealis*, whilst Dyar says that he has seen the caterpillars throw their pellets, with the aid of these spines, away from them, so as to strike against the side of a tumbler in which they were confined.

The "infra-anal lobe" is described by Packard as a "thick conical fleshy lobe or flap, ending often in a hard chitinous point, and situated directly below the vent. In appearance, it is somewhat like the egg-guide of the *Acrydii*, though the latter is thin and flat." Its use is, evidently, to aid in tossing the pellets of excrement away, so that they may not come in contact with the body.

Packard, in an article describing the larvæ of certain species of *Cerura*, gave it as his opinion, that the "stemapoda" or filamentous anal processes of these caterpillars were homologous with the anal prolegs of other Notodonts, and, to show this, figures the anal prolegs of *Dasylophia anguina* in its first larval stage. He points out, in his comparison, that it is intermediate in form between the normal anal proleg and the stemapod, and remarks that it "has no crochets, but the planta, of which the flagellum of *Cerura* seems to be the homologue, is retracted, and the retractor muscles, one of which is divided, are much as in the filamental legs of *Cerura*. It, however, is not the general opinion of British entomologists that the stemapoda are modified anal prolegs. Hellins regarded them as "dorsal appendages, somewhat after the fashion of the anal spines of the larvæ of the *Satyridae*." Packard discusses this view, and concludes:—"After repeated comparisons of the filamental anal legs of *Cerura* with those of *Macrurocampa marthesia*, and comparing these with the greatly elongated anal legs of young *Heterocampa unicolor*, as figured by Popenoe, and taking into account the structures and homologies of the supra-anal and paranal flaps, one can scarcely doubt that those of *Cerura* are modified anal legs." There appears to be no doubt whatever that Packard is quite right, and that the view hitherto held by British entomologists, is a wrong one.

The ancestral lepidopterous larvæ probably lived, at first, on grasses and low growing plants, and the arboreal habit was possibly assumed at a comparatively late period of larval evolution. This view is fully borne out by the geological evidence, for it is generally considered that flowering plants and trees were probably developed in the Cretaceous or Tertiary periods, and that our present race of lepidopterous insects became evolved side by side with the great changes that then took place in the flora of the world.

Many of the most highly developed groups of Lepidoptera—most of the Noctuids, Arctiids, Pierids, Satyrids, etc.—feed, even now, almost exclusively upon low plants, and we find that, amongst larvæ with this particular habit, the caterpillar is usually devoid of spines, and smooth or covered with a short, dense, velvety pile, whilst the markings consist chiefly of longitudinal lines of various shades of green, grey, etc., running from the head to the anus, dorsally, laterally, and ventrally. There are, of course, many very hairy and spiny larvæ that feed on low plants, but these live usually a more or less exposed life—neither hiding under leaves (like the Satyrids) nor stones (Noctuids and Crambids) by day—and the great development of hairs, pencils, spines and bristles, appears to be due often to the caterpillars having changed their mode of life from a concealed to an exposed condition, the change having frequently been accompanied by a move from a herbaceous to an arboreal feeding ground.

Just as the caterpillars of grass-feeding larvæ are green or grey in colour, and are chiefly ornamented with longitudinal lines of various shades, so the larvæ of arboreal caterpillars—Catocalids, Geometrids, etc.—have their bodies usually of a grey or ash colour, ornamented with dorsal and lateral humps, so that they may assimilate more readily with the colour of the bark of the tree upon which they rest, and to small twigs bearing leaf-buds, etc. But such larvæ as are particularly protected in this manner do not lead such exposed lives as do those which, by the modification of the tubercles and setæ of the more generalised larvæ, have developed conspicuous spines, pencils of hairs, etc., or those which, by the development of bright warning colours, ocellated spots, etc., present an inedible, or even dangerous appearance to the avian, and numberless other, enemies which surround them on every side.

Those larvæ which live upon trees, and trust for their escape to their resemblance to pieces of stick, etc., are sometimes remarkably tuberculated. This is particularly noticeable in the Geometrids and Notodonts. On the other hand, those larvæ which are arboreal, but which trust for their concealment to leafy abodes which they make and in which they dwell—such as the Tortricids, Pyralids, etc.—have retained, in many ways, much more generalised forms of larvæ, both as regards colour, markings and tubercles. The adaptation of exposed larvæ to their surroundings is also very remarkably illustrated in the case of many "plume" larvæ. No better illustration is needed than the similarity of the dermal clothing of the larva of *Aciptilia galactodactyla* to the woolly covering of the underside of the leaves of burdock (*Arctium lappa*), whilst Miss Murtfeldt quotes a parallel case among the American "plumes," stating (*Psyche*, iii., p. 390) that "there is a very close imitation in the dermal clothing of the larvæ of *Leioptilus sericidactylus* to that of the young leaves of *Vernonia*, on which the spring and early summer broods feed."

The inedible nature of hairs needs no demonstration. That many birds are able to eat hairy larvæ is no detraction from the general principle. The fact that some birds do eat hairy larvæ leaves unanswered the fact that there are numbers of birds that cannot; and, undoubtedly, many small insectivorous birds that would eat a Tortricid larva with gusto, and make no objection to its simple setiferous hairs, would object to a larva of *Arctia caia*, or that of *Acronicta leporina*. We may take it for granted that the ultimate use of spines and hairs is for protection, and further, that they have been stimulated in their development by natural selection, indicating to insectivorous birds that the bristly armature is inedible; yet it seems that we have hardly reached the bottom of the question, if we look upon the special development of the setæ and spines as due to protective needs, arising either from the attacks of birds or parasitic insects, but that we yet require some explanation of the initial cause of the development of such spines and specially developed hair structures.

Fritz Müller, in 1864, maintained that the so called metamorphoses of insects, in which these animals quit the eggs as grubs or caterpillars, and afterwards become quiescent pupæ, incapable of feeding, was not inherited from the primitive ancestor of all insects, but was acquired at a later period. Brauer, in 1869, divided* the larvæ of insects into two groups, the "campodea" form and "raupen" form. In 1871, Packard† adopted these views, and gave the name of "eruciform larvæ" to the cylindrical larvæ of certain Coleoptera (weevils, etc.), as well as to those of Diptera, Lepidoptera, and Hymenoptera, considering that the larvæ of all these were the result of adaptation, and were "derivatives of the primary 'campodea' type of larva." Lubbock practically adopted* Brauer's views in 1873. In 1895, Packard considered† that, "while the origin of the eruciform larvæ of the *Cerambycidae*, *Curculionidae*, *Scolytidae*, and other wood-boring and seed-inhabiting and burrowing coleopterous larvæ in general, is plainly attributable to adaptation to changed modes of life, as contrasted with the habits of roving, carnivorous campodeiform larvæ, it is not so easy to account for the origin of the higher metabolous orders of Diptera, Lepidoptera, and Hymenoptera, whose larvæ are all more or less eruciform." He supposes them all to have arisen independently from groups belonging to the Neuroptera (in the modern sense), or to some allied but extinct group.

---

* "Betrachtungen über die Verwandlung der Inseckten, etc.," *Verh. K. K. Zool. bot. Ges. Wien*, 1869.

† *American Naturalist*, September, 1871.

In 1895, we suggested‡ that the earliest forms of lepidopterous larvæ were hidden, and probably internal feeders. This view is not shared by Packard, who suggests that the earliest type was "allied to some Tineoid which lived, not only on land, but on low herbage, not being a miner or sack-bearer." This conclusion is arrived at by his consideration of the remarkable changes in form of certain Tineoid mining larvæ, described and figured by Chambers‖ and Dimmock.§ These larvæ were those of the Lithocolletids, Gracilariids, etc., and we quite agree that these apodous forms of mining larvæ are the result of adaptation to their habits. Our own idea of the ancestral form was, and is, one more closely resembling those of *Hepialus*, *Cossus* or *Zeuzera*, but the point matters little. What most authorities are agreed upon is—that by the time the ancestral larva was essentially lepidopterous, it was provided with prolegs that bore terminal crochets or hooks, and with simple fleshy warts or tubercles bearing simple hairs. The various forms in which the crochets are now arranged on the prolegs, and the many modifications which one finds in the arrangement and character of the piliferous tubercles, must be looked upon as more recent developments.

Meldola first suggested¶ that the green colour of many caterpillars was due to the presence of chlorophyll in their tissues, and the matter was carried much further by Poulton* in his experiments on the larvæ of certain species of the genus *Smerinthus*. Packard thinks that the cuticle was at first colourless or horn-coloured, and suggests that "after habitually feeding in the direct sunlight on green leaves, the chlorophyll thus introduced into the digestive system, and into the blood and the hypodermal tissues, would cause the cuticle to become green," whilst, afterwards, "by further adaptation and by heredity, this colour would become the hue common to caterpillars." In view of Poulton's more recent experiments† it would not do to labour this point too much, and we are inclined to agree with him, that the effect is rather "phytoscopic" than "phytophagic," inasmuch as the colour of the surface of the leaf, rather than its substance, acts as the stimulus, and this view has been materially strengthened by his experiments on larvæ, such as *Rumia luteolata*, etc., which show so much initial variation in nature, that some are green and some brown. His observations on larvæ of this species, as well as on those of *Ennomos quercinaria* (*angularia*), *Selenia lunaria*, *Crocallis elinguaria*, *Phigalia pedaria*, and, above all, *Amphidasys betularia*, show conclusively that the colour of some larvæ is much affected by the surrounding environment, and hence, as a general conclusion, we must assume, as far as our knowledge at present goes, that the general green colour of those larvæ which essentially live among green leaves, is due rather to the influence of the particular environment surrounding them than to any direct action of the chlorophyll, which is consumed with their food. Commenting* on these experiments, Poulton says :—" Of the colour changes we must distinguish two main kinds : (*a*) Changes in the colour of the true animal pigments, leading to various shades of brown, grey, etc. (*b*) The change to a green colour modified from plant pigment, in the food. When such a change of colour is possible, the true pigments are always superficial to the green, and cannot be retained without concealing the latter, the degree of concealment depending on the amount and distribution of pigment. Thus, in *Amphidasys betularia*, the true pigments are chiefly placed in the epidermic cells, the green in the subjacent fat, whilst in many others, the former are in the superficial layer of the cuticle, the latter in the blood, or sometimes in the lower layers of the cuticle. But the appearance of the green is not merely the removal of a screen, although this must occur ; in some cases, at any rate, it also means the formation of the green colouring matter itself."

---

* *Origin and Metamorphosis of Insects*, 1873. † *Bombycine Moths of America*, 1895.

‡ *Entom. Record*, etc., vii., p. 6.

‖ *American Naturalist*, iii., 255-262 ; *Psyche*, ii., 81, 137, 227, etc.

§ *Psyche*, iii., pp. 99-103. ¶ *Proc. Zool. Soc. of London*, 1873, p. 159.

* *Proc. Roy. Soc. Lond.*, 1885, p. 269. † *Trans. Ent. Soc. Lond.*, 1892, pp. 294 *et seq.*

Probably the first attempt at ornamentation in the lepidopterous larva consisted of longitudinal lines. These usually consist of (1) The dorsal or medio-dorsal line (a line running down the centre of the dorsum, throughout its whole length). (2) Sub-dorsal lines (one on either side of the medio-dorsal line). (3) Supra-spiracular lines (one on either side above the spiracles). (4) Sub-spiracular lines (one on either side below the spiracles). Sometimes there is a spiracular line running along and including the spiracles. The medio-dorsal line (as such) is probably, occasionally, due to the alimentary canal showing through the skin. It is certainly so in many transparent-skinned larvæ (*Ephestia kühniella*, etc.), and it is just possible that, whatever form its modifications may now take, it originated in this manner. Weismann has concluded, from his studies of the Sphingids, that the sub-dorsal line arose before the spiracular, and Packard† shows how, after the sub-dorsal and spiracular lines are formed, others are rapidly introduced—and some may as rapidly vanish, as necessary features of certain stages—which, when they become useless, are discarded.

Weismann, in his *Studies in the Theory of Descent*, has shown that the primitive markings of caterpillars were lines and longitudinal bands. He further shows that larval spots are formed by interruptions, " the serial atrophy," of the lines or bands. Packard says : The lines, bars, stripes, spots, and other colorational markings of caterpillars, by which they mimic the colours and shadows of leaves, stems, etc., have evidently been, in the first place, induced by the nature of the food

---

* *Trans. Ent. Soc. Lond.*, 1892, pp. 458-459.

† *Bombycine Moths of America*, p. 15.

(chlorophyll), by the effects produced by light and shade, by adaptation to the form of the edge of the leaf (as in the serrated back of certain Notodonts), by adaptation to the colours of different leaves and to the stems, since shades of greens, yellows, reds, and browns, are almost as common in the cuticle of caterpillars, as on the surface or cuticle of the leaves and their stems, or in the bark of the twigs and branches. He also adds that probably many have observed that the peculiar brown spots and patches of certain Notodonts do not appear until late in larval life, and also late in the summer, or early in the autumn, contemporaneously with the appearance of dead and sere blotches in the leaves themselves. This phase of the subject will be dealt with at length in a later chapter.

Tactile hairs, defensive setæ, locomotive setæ, and spines of various kinds, occur in worms; these, too, often arise from fleshy warts or tubercles. It is, therefore, not at all unlikely that the ancestral lepidopterous larva was provided with piliferous warts, and that many of the specialised spines, etc., now found in lepidopterous larvæ, are modifications of these ancestral simple structures.

It may be safely assumed that spines, hair-tufts, etc., serve to protect the organism from external attack, probably also to strengthen the shell or skin. That even the most complex spines are modifications of the tubercular structure is evident if one examines the cast skin of a Vanessid larva when it has just been thrown off, and the pupal state assumed. Packard, in a long argument,* suggests that "it is not improbable that tubercles, humps, or spines, may have in the first place been developed in a few generations, as the result of some change in the environment during the critical time attending or following the close of the Palæozoic, or the early part of the Mesozoic age, the time when deciduous trees and flowers probably began to appear." The same author refers to Darwin's significant remark† that "organic beings, when subjected during several generations to any change whatever in their conditions, tend to vary," further, that "variations of all kinds and degrees are directly or indirectly caused by the conditions of life to which each being and, more especially, its ancestors have been exposed" (p. 241) and again, that "changes of any kind in the conditions of life, even extremely slight changes, often suffice to cause variability. Excess of nutriment is, perhaps, the most efficient single exciting cause."

Referring to the geological fact, that in the Cretaceous period, the forests consisted of oaks, maples, willows, beech, poplar, etc., Packard assumes that, in all probability, the low-feeding caterpillars of that time began to desert the herbaceous plants to feed on trees, and that they then experienced sufficient change to induce considerable variation, and that, to a great extent, tree-feeding necessitated isolation. He thinks, moreover, that the change from herbaceous to arboreal feeding, not only affected the shape of the body, causing it to become thick and fleshy, but also led to a hypertrophy of the piliferous warts, common to all lepidopterous larvæ. We deal with this at length, not because we are inclined to agree with its assumptions, but because no other explanation of the actual origin of the cause of the modification has been offered.

---

* *Bombycine Moths of America*, pp. 16 *et seq.*

† *Variation of Animals and Plants under Domestication*, 2nd Edition, 1888.

We find, in definite positions on the larval cuticle, small buttons of chitinous material called tubercles. These usually bear a structure, formerly termed a "hair," but to which the term "seta" is now usually applied, since the seta is not morphologically equivalent or homologous with the hairs of mammals. These setæ arise through a modification and hypertrophy of the nuclei of certain cells of the cuticle. According to Dyar, the "primitive form of tubercle consists of a little chitinous button on the skin, bearing a single long hair. It is found in the less specialised groups of Lepidoptera, and exclusively in the JUGATÆ and the Psychids. When this form is present, there are, in general, no other hairs on the body."

It would appear that in the phytophagous Hymenoptera (*Tenthredinidae*), there are well-developed setiferous tubercles, apparently more generalised than those found in any Lepidoptera, but in the Lepidoptera there appear to be, according to Dyar, two types of arrangement. (1) By far the more generalised, consists, on the abdominal segments, of five tubercles above the spiracle on each side, three in a transverse row about the middle of the segment and two behind, whilst below the spiracle are two oblique rows, containing respectively two and four tubercles. This type is found in *Hepialus*. (2) The second type consists of two dissimilar lines of modification of the first type, of which the fundamental arrangement consists of three tubercles on each side above the spiracle; three more on each side, below or behind the spiracle and above the base of the leg; and three (or four) on the base of the leg on the outside, and one on the inside near the mid-ventral line.

As Dyar has made himself quite an authority on these setiferous tubercles, it may be well to glance at his nomenclature. Commencing from the dorsum, he calls the tubercles above the spiracles i, ii, iii,* the three below, iv, v, and vi†; the group on the outside of the leg is known as vii, and the single one on the inside of the leg as viii. Tubercles vii and viii, Dyar says, are present also on the legless abdominal segments (1, 2, 7, 8 and 9), in a position corresponding to those on the segments bearing prolegs. On the last two abdominal segments (9 and 10) the number of tubercles is always less than the fundamental number, even in generalised larvæ. This is evidently due to the fact that these segments have been partly aborted, being without spiracles. The reduction of the ninth abdominal segment has taken place on the anterior portion, whilst the tenth abdominal has lost the lateral part (*Classification of Lep. Larvae*, pp. 196-7). Dyar's conclusions as to the relationship which the lepidopterous superfamilies bear to each other are based on (1) The position of the tubercles with regard to the sub-segments into which the abdominal segments are divided. (2) The tendency for tubercles iv and v (the post-spiracular and sub-spiracular tubercles) to coalesce or separate.

As to their position, Dyar says that in the JUGATÆ (Hepialids) the three tubercles of the middle sub-segment are all present, and the upper and lower of the posterior sub-segment. In the Psychids, the three tubercles are retained on the middle sub-segment, but both are

---

* i = anterior trapezoidal, ii = posterior trapezoidal, iii = supra-spiracular.

† This is a secondary tubercle, absent usually in the newly hatched (generalised) larva of the higher families. Hence its importance is less valuable than Dyar afterwards insists, when discussing the Psychids and MICRO-FRENATÆ.

lost on the posterior one; the sub-stigmatal tubercles are retained and approximated, the anterior one of the four on the base of the leg seems to have been moved up, forming tubercle vi, which is thus anterior (=pre-spiracular). This explanation accounts for the possible formation of the pre-spiracular tubercle as such, for it will be observed that, whereas tubercle v of Dyar is the typical sub-spiracular tubercle of the more specialised families, tubercles iv and vi, typically originating below the spiracle, according to Dyar, become respectively the post-spiracular and pre-spiracular in special instances. In all the other families of the Lepidoptera, Dyar states that the middle tubercle of the three on the middle sub-segment is lost, but the upper on the posterior sub-segment is retained; the two (iv and v) below the spiracle are also retained, as in the Psychids, but they are either approximated (sometimes even united to form a compound sub-spiracular tubercle, as is *Margarodia*), or separated so as to form two distinct tubercles, *viz.*, the sub-spiracular and post-spiracular, whilst of the four tubercles at the base of the leg, the posterior one (not the anterior one, as is the case in the Psychids) is moved up to form tubercle vi.

The tendency for tubercles iv and v to coalesce so as to form a compound sub-spiracular tubercle, appears to be characteristic of the larvæ which comprise, in its broad lines, Comstock's MICROFRENATÆ or GENERALISED FRENATÆ, whilst the tendency for tubercles iv and v to separate and form post-spiracular and sub-spiracular tubercles, respectively, appears to be characteristic of his SPECIALISED FRENATÆ.

Dyar notes, and if it held good it would be very curious, that "it is a striking fact that we do not find a series of intergrading forms between the single-haired tubercle and the many-haired wart, though both may occur in different genera of the same family," and he considers that this is explicable on the principle of discontinuous variation, which is insisted upon by Bateson. He says that in the lower (more generalised) families we have the simple and primitive form of tubercle; in the more specialised families we find a modification, which consists in the tubercles becoming enlarged and many-haired. In these compound tubercles each hair arises from its own minute tubercle, and the whole are borne upon an enlarged base or wart. Modification then takes place in the higher groups, by a reduction in the number of tubercles, the reduction taking place:—(*a*) By coalescence. (*b*) By unequal development and final obliteration of particular ones. (This is discussed later in chapter.)

We have seen that in some of the more specialised larvæ there is a general tendency to the reduction of tubercles, so that some may entirely disappear. In some cases, however, the bases of the tubercles are developed into long fleshy processes, carrying aborted setæ, as in the case of certain larvæ of the Nymphalids, Papilionids, etc. In other cases, the setæ remain as glandular hairs, in some instances secreting an urticating (? odorous) fluid, or the hairs themselves become highly specialised, and greatly increased in number, forming brushes, tufts, plumes, etc., as in the larvæ of Acronyctids, Liparids, Arctiids, etc.

One of the most striking modifications of the tubercles is seen in the caudal horn of the SPHINGIDES. This is an unpaired dorsal process on the 8th abdominal segment. A figure of the larva of *Deilephila euphorbiae* (Weismann, *Studies in the Theory of Descent*, Pl. v., fig. 38) in its first skin, shows that the two setæ of tubercle i are borne on the apex of the caudal horn. This would point strongly to the conclusion that the horn represents the base of the unconsolidated pair of tubercles i, the tubercles themselves having disappeared. This disagrees with Poulton's view,* for he looks upon the caudal horn as representing the consolidated pair of tubercles i of the Saturniids.

The caudal horn of the remarkable genus of Plume moths, *Agdistis*, does not, according to Bacot, rise from the 8th abdominal segment, and bear the anterior trapezoidals of that segment, as in the Sphingids, but is situated on what is either a small 9th abdominal segment, or a large and distinct subsegment of the 8th abdominal, both the anterior and posterior trapezoidals of the 8th segment being in front of the horn, and in their correct position relative to the spiracle.

The production of a central row of dorsal tubercles apparently unpaired, in certain families, is very remarkable. This is well seen in the medio-dorsal row of spines in the adult larvæ of certain Vanessids, where, too, the real nature of the spines forming this row may be readily learned, by comparing the adult larvæ with those in their earlier stages. They are formed by the union of tubercle i on each side, consolidating on the central line of the dorsum. A similar arrangement also occurs in the Saturniids.

The modifications which tubercles and setæ undergo have been tabulated by Packard.† His table reads as follows :—

A.—TUBERCLES.

a.—Simple and minute, due to a slight thickening of the hypodermis, and a decided thickening of the overlying cuticle; the hypodermis contains a large unicellular gland, either for the secretion of the seta or for the production of poison.

1.—Minute piliferous warts (most Tineid, Tortricid and Noctuid larvæ).
2.—Enlarged smooth tubercles, bearing a single seta (many Geometrid and Bombycine larvæ).
3.—Enlarged spherical tubercles, bearing a number of setæ, either radiated or subverticillate (Arctians, Lithosians).
4.—High, movable, smooth tubercles, having a terrifying function (*Schizura*, *Xylinodes*, *Notodonta*, *Nerice*).
5.—Low and broad, rudimentary, replacing the "caudal horn" (*Choerocampa*, *Leiocampa* (*Pheosia*) *dictaea*, and *L. dictaeoides*).

b.—More or less spinulose or spiny (disappearing in some Sphinges after Stage 1).

1.—Long and slender, usually situated on the top of the eighth abdominal segment, with microscopic spinules in Stage 1. (Most *Sphingidae* and *Sesia*‡).
2.—Smooth subspherical warts (*Chalcosia*, East Indies) ; or elongated, but still smooth (*Attacus atlas*).
3.—Subspherical or clavate spiny tubercles of many *Attaci* ; the spinules usually short.
4.—Spinulated spines or elongated tubercles of *Ceratocampidae* and *Hemilucidae* (*Automeris io* and *Hemileuca maia*, etc.).
5.—Spike-like hairs or spines (*Samia cynthia*, *Anisota*, *Hypsa* (E. Indies), *Anagnia*).
6.—Antler-like spines. Early stages of *Heterocampa binndata*, *H. guttivitta* and *H. obliqua*).

---

* *Trans. Ent. Soc. Lond.*, 1888, pp. 568-574. † *Bombycine Moths of America*, p. 21.

‡ Packard does not use *Sesia* in the sense usually understood in Britain, *i.e.*, for the true Clearwing moths, but as a synonym of *Macroglossa*.

B.—SETÆ (HAIRS, BRISTLES, ETC.).

1.—Simple, fine, short or long, macroscopic or microscopic setæ, tapering hairs, scattered or dense, often forming pencils (many Bombyces, *Zygaenidae*,* Noctuo-Bombyces, *Apatelae*).
2.—Glandular hairs, truncate, spindle-shaped or forked at the end, and secreting a more or less viscid fluid [many Notodonts in Stages 1 and 2; many butterfly larvæ; *Pterophoridae* (in last stages)].
3.—Long spindle-shaped hairs of Apatelodes (*Apatela americana*), and *Tinolius eburneigutta*.
4.—Flattened, triangular hairs in the tufts, or on the sides of the body of *Gastropacha americana*, or flattened, spindle-shaped scales in the European *G. quercifolia*.
5.—Spinulated or barbed hairs (most Glaucopides, Arctians, Lithosians, Liparids and many Bombycids).

C.—PSEUDO-TUBERCLES.

1.—Filamental anal legs (stemapoda) of *Cerura* and *Heterocampa marthesia*.
2.—The long suranal spine of *Platyptericidae*.

Before leaving our consideration of the hairs of larvæ, it may be well to mention the spathulate hairs of *Jocheaera alni*. These are usually erect and conspicuous, but in the adult stage are spread somewhat laterally. Chapman gives them as measuring, in the 4th larval skin: on pro-thorax, 3¼ mm., on 5th abdominal, 1½ mm., on 9th abdominal, 2½ mm.; in the 5th larval skin, on the same segments 6, 3½ and 4 mm. respectively, and in the 6th larval skin (extra moulter), 7, 4, and 4½ mm. respectively. The larva of *Eutricha quercifolia* and those of other species possess remarkable scale-like hairs, as mentioned above by Packard.

The study of the newly-hatched larva is one of the most important factors in considering the phylogeny of the lepidoptera, for it happens that many species which have the most specialised adult larvæ hatch in a very generalised condition, and hence, comparison of the tubercles in the newly-hatched larvæ, with the more specialised structures that replace them afterwards, gives many valuable clues to the origin of the complicated structures of the adult. From this, it would appear, that the more primitive arrangement of the five chief tubercles and setæ occurring on the abdominal segments, is such that the three tubercles above the spiracle exist as the anterior trapezoidal, posterior trapezoidal, and supra-spiracular tubercle, respectively, whilst the sub- and post-spiracular tubercles are both placed beneath the spiracle. Dyar remarks† :—"Curiously enough, the most generalised condition is exhibited in the first stage of the butterflies (Rhopalocera). This is to be accounted for by the fact, which was brought out by a comparison of the first stage of such genera as *Danais* and *Grapta*, with their later stages, *viz.*, that the armature of the butterfly larva is not developed mainly from the primary tubercles, but almost entirely independent of them." This is certainly too sweeping an assertion to comprise the facts relating to the armature of the Vanessid and Argynnid larvæ, and probably some others. In many cases there can be no doubt that the armature is frequently developed from the primary tubercles, often, of course, with certain stages of the evolution left out. In some the process of development is comparatively simple, as may be seen, if the larva be examined carefully at each ecdysis. The case of *Aglais urticae* and others occur to me.

---

* As used in America, this = our *Euchromiidae*, which are Arctiids, not the family British lepidopterists call *Zygaenidae*.

† "Additional notes on the classification of Lepidopterous larvæ," *Trans. New York Acad. Sci.*, xxv., p. 52.

The horn which characterises the Sphingid caterpillars is, as we have seen, placed on the dorsum of the eighth abdominal segment, and it is remarkable that when it is absent in allied forms, it is replaced by a small, low and flattened tubercle, the segment itself being somewhat swollen. Many Noctuid larvæ—*Amphipyra*, *Mamestra persicariae*, etc., have a prominent hump on this segment, so also have the larvæ of the *Agaristidae*, and others. In many Notodont larvæ the first abdominal segment bears a conspicuous hump, sometimes forked, often ending in a seta. It would appear, from Packard's researches, that the three thoracic segments, and the first and eighth abdominal segments, are those most usually characterised by tall fleshy tubercles, horns, etc. The same author shows that the first and eighth abdominal segments bear no prolegs, and that, when walking, these apodous segments are more raised than the others, and that, if it be true, as it appears to be, that these humps do frequently rise from the most elevated portions of the larva when crawling, then the movement of these conspicuous structures might tend to be of service in frightening away other creatures. He further suggests that the humping or looping of these segments may have had something to do with inducing the hypertrophy of the dermal tissues which enter into the formation of the tubercles or horns, whilst with regard to the mutant or movable tubercles, he suggests that the movement of these appendages would suffice to scare off an approaching ichneumon or *Tachina*.

Larvæ are, of course, subject to the conditions involved by the struggle for existence, and to modification in relation to environment, and, hence, is due the modification of the setiferous tubercles, by which the larva is made to resemble different objects at different phases of its existence. Everyone knows how different is the larva of *Jocheaera alni** in its third skin, in what is known as the "birds'-dropping" stage, from the adult larva with its conspicuous bulbous-tipped hairs. This reference to a subject already discussed in a previous part of this chapter (p. 47) gives us a chance of explaining why we have thrown doubt upon Dyar's statement that "we do not find intergrading forms between the single-haired tubercle and the many-haired wart." He probably had in mind some such change as that occurring in the Anthrocerids, in which the simple single-haired tubercle of the first skin becomes a many-haired wart in the second, increasing in size at each subsequent moult. It happens, as a matter of fact, that intergrading forms are exceedingly common in many species of Lepidoptera, a single-haired tubercle in the first skin acquiring some hairs at each subsequent moult, until it becomes a wart. In the Acronyctid larvæ there are various stages in different species, even in the first skin, the differences extending from a one-haired tubercle, two-haired tubercle, etc., to a many-haired wart, and such cases are not at all uncommon. In the case of *Anthrocera*, it is possible that some stages in the evolution of the many-haired wart are now missed, but, in others, the intergrading forms are, as we have said, by no means unknown.

---

* Chapman, *Entomologist's Record*, etc., vol. ii., p. 123.

The varied stages of development of the setiferous tubercles, sometimes reached in allied genera in the egg, is of the highest significance, as is also their comparative development in the various stages of the larvæ of allied genera, as in *Ornithoptera* and *Papilio*, in *Aglia* and *Citheronia;* whilst Packard* states that the "tubercles of the adult larvæ of *Saturnia* (*pavonia* and *pyri*) are on the same plane with the embryo, just before exclusion, of the more highly specialised forms of the group *Attacinae*," and, again, "whilst the late embryos of the *Attacinae* are, perhaps, paralleled by the fully-grown larva of *Saturnia*, the fully-grown larva of the most, or one of the most, generalised of the *Attacinae*, *Platysamia*, is on the same plane of specialisation as the larva of *Callosamia* in its third stage."

The larvæ of a large number of Lepidoptera are provided with what may be fairly termed glandular setæ. They are more especially abundant in young larvæ, and occur in butterflies (Pierids and Satyrids), Geometrids (*Ortholitha cervinata*), Notodonts (*Datana*, *Dasylophia*), and many others. Packard describes the glandular hairs of newly-hatched larvæ of *Ceratosia tricolor* as "flattened at the tip, which is slightly tridentate, with grooves passing down the shaft from the notches between the teeth." In the Pierids they form an open basin, fringed with cilia, supported on an exceedingly slender, hollow pedicel, the hairs looking as if tipped with dew.

In a preceding part of this chapter (p. 40), we query the absence of the paranal forks in the Rhopalocera. This is because Chapman has called attention to a well-known structure, called the "anal comb," which is possibly homologous with the paranal forks. It is found just under the anal flap in many Tortricid, Hesperid, and Pierid larvæ. Scudder figures the anal comb in *Colias* (*Eurymus*) *philodice*, but does not seem to mention it in the text. This should, of course, have been mentioned directly after the paragraph referring to the "paranal forks."

It has been repeatedly noticed that certain larvæ, when confined, have a tendency to crawl upwards, and this is more particularly the case with some species than others. Larvæ of the genus *Coleophora*, *Aglais urticae*, *Vanessa io* and others, might be instanced as always taking possession of the highest possible point of any receptacle in which they may be placed. Poulton suggests that this is due to the fact that the larvæ in these movements are guided by an appreciation of the force of gravitation. That it is not always in order to seek food is evident, for the larvæ will crawl over the food-plant in order to reach the highest available point. It is very possible that these movements are made in order to seek light, or air. At any rate, it is not yet at all clear how far the latter causes are factors in bringing about these movements, and how far the force of gravity has effect.

Poulton further considers that the force of gravity has been potent in bringing about the characteristic "Sphinx-like" attitude that characterises the larvæ of certain Sphingids, *Aglia*, etc. This attitude, he says, bears a distinct relationship to the position assumed by these larvæ. The thoracic legs, in such larvæ as adopt this attitude, are not used for the support of the body, and, hence, when

---

* "Studies in the Transformation of Moths of the Family Saturniidæ," *Proc. Amer. Acad. Arts and Sciences*, 1893.

the larva is clinging as is its wont, the weight of all the parts of the body anterior to the third abdominal segment is only indirectly supported by means of the claspers. He further points out that the young larvæ of all species which exhibit this habit, habitually rest on the underside of leaves, and, therefore, have the dorsal area pointing downwards. Under these circumstances "the organism reacts upon the strain, and the muscular body-walls strongly contract upon their fluid contents in such a manner as to produce compensating rigidity, and thus give to the body the curve which is characteristic of the attitude. The Sphinx-like attitude is to be explained as the combined effect of gravity and of muscular reaction upon the anterior unsupported parts of the body. The muscular arrangements, which are most favourable for counteracting these strains, are also made use of in the older larvæ for the maintenance of a feebly marked Sphinx-like attitude, when the larva is seated on the upper side of a horizontal twig. The attitude is most strongly marked when the larva is resting on a vertical twig, because gravity tends to draw the anterior part of the body backwards as well as downwards. These large larvæ habitually rest on vertical twigs, with the head uppermost, because the twig itself is approached from its base, and gradually stripped of leaves towards its apex. The essential dependence of the attitude upon gravity is well seen, when a vertical twig, with a larva upon it, is carefully bent downwards, so that the strain is in the opposite direction, and tends to bend the anterior part forwards instead of backwards. Under these circumstances the larva begins to yield to the strain in a few minutes (*Trans. Ent. Soc. Lond.*, 1888, p. 675).

An interesting subject of enquiry is the evolution of the Geometrid form. The fact that this form is found, in a more or less modified condition, in certain Noctuid larvæ, has suggested an alliance between the two groups. It seems very probable, however, that this similarity has been brought about by somewhat similar needs, the Geometrid form being, in many respects, a very specialised one. Many Noctuid larvæ that have the full number of prolegs when adult, are more or less Geometrid in form when young. It appears probable that this form has been developed in order to give these larvæ a greater reach (1) to obtain their food, (2) to travel from one twig to another. The Geometrids are essentially herbaceous and arboreal in their habits, remaining on their food-plants the whole of the day, so also are the Plusias and other Geometriform Noctuids. The Noctuids that have a Geometrid form of progression when young, also, at this period of their lives, remain on their food-plants, but when they gain the hitherto absent prolegs, they climb down the plants and hide at the roots, or under the ground by day, ascending the plant again to feed by night. The comparatively low-feeding Geometrid larvæ are, as a rule, small species, and the bushy herbs on which they feed, bear to their power of reach much the same proportion as the larger trees bear to the reaching power of the larger larvæ. Another view of the matter suggests itself, *viz.*, the necessity of Geometrid larvæ to travel more quickly than other tree-feeding larvæ. The Sphingids, Saturniids, Lasiocampids, Dicranurids, Catocalids, etc., are specially protected by spines, hairs, etc. The Geometrid larva is naked, usually only protected by the resemblance of its colour to its environment, and by its power to remain rigid and motionless. When moving, therefore, it is helpless, and must travel from place to place with as much speed as may be possible. Every observer knows that the tree-feeding larvæ of the other groups mentioned above are extremely slow in their movements. It is essential, above all things, that a tree-feeding larva should hold very firmly, and this it is enabled to do by spinning silken threads and ladders, and by the possession of remarkably strong and well-developed prolegs. The large Saturniids, arboreal Sphingids, Lasiocampids, etc., cling with amazing tenacity, but, at the same time, they walk with extreme slowness. With them, the opening and closing of their prolegs is a remarkably complex operation, in which a whole army of muscles is brought into play. The Geometrid larva has to cling as tightly as these. At the same time it has to move more rapidly, hence it has reduced its prolegs to the smallest possible effective number, and has, especially, anal ones of the very best kind. Thus it is able to obtain a long stretch for each step, and is able to progress with comparative speed. The young Noctuid larva, too, has often a considerable amount of travelling to do in search of food (eggs being often laid away from the food-plant, etc., *ante*, p. 13), and a certain amount of looping increases its activity by lengthening the step; and this is, perhaps, much more important in the young state when the larvæ have an arboreal habit. It may be, therefore, that rapidity and facility of progression is a great part of the object in view. An Arctiid larva, when travelling rapidly, hardly uses the prolegs at all, but progresses by a rapid looping movement, the ordinary progression, segment by segment, being altogether too slow for its needs.

Every field naturalist has observed how a Geometrid larva will maintain its hold upon a twig and eat a leaf, and, for this, reach is also required. The difference between the way in which a tree-feeding Geometrid larva and a Sphingid larva will attack a leaf is remarkable. The Geometrid stretches itself out to its full length, and eats as much as it can reach without moving, often beginning near the tip and devouring the whole leaf. The powerful Sphingid larva pulls the leaf towards itself, and thus does by greater strength what the Geometrid larva does by greater reach.

The Geometrid form, therefore, appears to be correlated with habits of (1) greater reaching or stretching power, (2) greater speed. It does not seem to have any important phylogenetic significance.

In a previous part of this chapter, we have referred to the fact that lepidopterous larvæ have a certain number of ocelli on each cheek. Landois considers that these do not essentially differ from compound eyes, and states that if many of them were grouped together they could hardly be distinguished from compound eyes. In each ocellus, he says, the cornea is divided into three lenses, each corresponding to three nerves, each with a separate terminal enlargement, forming the so-called crystalline bodies. Each ocellus, therefore, might be regarded as being, in reality, composed of three. On the other hand, the three arches of the cornea are so closely connected together, that they give the impression of forming a simple cornea. The three lenses are also very closely pressed, and the three nerves unite into one. Under these circumstances, Landois regards the ocelli of caterpillars as a connecting link between simple and compound eyes, and proposes for them the name of "ocelli compositi." Chapman says: That the larval ocelli are descended from compound eyes, or are persistent from the embryonic form of compound eye, is undoubted. They often occupy a definite tract on the head, which probably represents the area of the compound eye, of which some ocelli only are developed (*in litt.*).

There has not, we believe, as yet, been any attempt to locate an organ of hearing in the larvæ of Lepidoptera, although various authors have done so in the imago. Swinton summarises (*Ent. Mo. Mag.*, xiv., p. 121) the various notes that have appeared on the aural apparatus of Lepidoptera. There is direct evidence that some larvæ, at least, show considerable sensitiveness to sound waves. We have noticed that larvæ of many species—*Aglais urticae*, *Callimorpha dominula*, *Nemeophila plantaginis*, and *Lasiocampa quercûs*, among others—throw their bodies violently from side to side, if one speaks in a loud tone, when in their vicinity.

CHAPTER VI.

THE INTERNAL STRUCTURE OF THE LEPIDOPTEROUS LARVA.

The external characters of the lepidopterous larva are, owing to the division of the body into segments, each with its own special organs and appendages, easily described, and the position of these structures located. The location of the internal organs is, however, more difficult, for they are not restricted to certain segments, but run longitudinally through the body, frequently extending from the thorax forward into the head, or backward into the abdomen. It is necessary, therefore, in dealing with the internal organs, to consider each separately, both as regards its position and function.

The movements of the body are of the first importance, and we find that larvæ have undergone great modifications in order to enable them to vary their movements according to their needs. Movement is dependent upon the muscular system, and by the muscles, then, the changes that take place in the external framework and appendages are brought about. The nutrition of the various parts is carried on by food, and to understand this we must study the digestive system. The absorption of the digested food into the blood and its carriage to all parts of the body necessitate a circulatory system, whilst the oxygenation of the blood introduces us to the respiratory system. This latter is so intimately connected with the excretion of waste, that one is insensibly led to consider the excretory system, whilst the organs, by which the whole of these various systems are governed, comprise what is known as the nervous system, and this has to be considered both in its relation to volition and sensation.

These various systems comprise, then, the different organs (and their functions), by means of which the life of an insect is carried on, and their external results, as exemplified by their movements, etc., are the outward sign of their vitality. The reproductive system, which is not, however, matured in the larval stage, must take the highest place in relation to the continued life of the species. Closely related, too, with the digestive, is the cellular, system, by means of which the caterpillar is able to store up large quantities of surplus material for use in the later stages of its metamorphoses.

The voluntary muscular system of the caterpillar is that by means of which it is enabled to move about in order to obtain its food. The muscular fibres are usually arranged in the form of flat ribbons, or conical bundles. The latter make up almost the whole structure of the head, are fastened chiefly to the head walls, and end as fine tendinous cords, attached to the various organs which the insect is thus enabled to move. In this way, certain muscles reach down into the mandibles, which they close when they contract; whilst the mandibles are opened by muscles which are attached to their outer bases and to the head, just below the ocelli. Other fine flat retractor muscles draw the labrum inwards, whilst extensor muscles work in the opposite direction. A series of contiguous muscular cords, often forming a double band of simple, longitudinal muscular fibres, runs from one end of the body to the other, on each side, just under the skin, between the spiracles and the ventral area of the body. Muscular bands, too, run transversely and obliquely in the front of each segment, and are attached to the medio-ventral line farther back in the segment. Above the spiracles on each side are other longitudinal bands, made of three layers, whilst between these and the skin, at the front of each segment, a transverse muscular belt encircles the body, passing at the spiracular region over the longitudinal tracheal vessel, which unites the contiguous spiracles, and straps it to the integument. The flexor muscles of the true legs arise just beneath the longitudinal straps, previously described as running between the spiracles and the ventral area, and extend to the opposite wall of the segment in which they take their rise. The muscles of the prolegs are somewhat different, flat bands forming, as it were, a muscular coating to the walls of the legs just beneath the skin. Usually, these pass directly down, narrowing as they go; the muscular fibres, too, appear not to cross to opposite sides of the leg.

The involuntary muscular system is principally connected with the digestive and the circulatory organs. The œsophagus is provided with fine longitudinal bands of muscular fibres, and also with less well-developed transverse encircling bands. The inner coating of the stomach is enclosed in delicate strips of muscular fibre, crossing each other diagonally; besides these, longitudinal muscles run throughout its length, and well-developed transverse muscles encircle the stomach similarly to those found in the œsophagus. The arrangement of the muscular tissue in the intestine, in longitudinal and transverse bands, is very similar to that in the other parts of the alimentary canal, but, in this, the longitudinal bands are often thick, white and glistening, whilst near where the small intestine joins the stomach, the walls are plentifully supplied with short longitudinal muscles. The diagonal bands found in the stomach have also their representatives here.

The alimentary canal is held in its place by a series of muscular bands attached to the body wall, one set passing round that portion of the intestine where it is connected with the stomach, another set being attached to, and supporting, the posterior end of the small intestine, these muscles stretching horizontally from the middle of one side of the 8th abdominal segment to the opposite side.

The mouth opens into a long narrow tube (the œsophagus), into which several long tubules pass. These represent the salivary glands of the higher animals, and secrete a fluid, which is discharged into the œsophagus, and which is swallowed with the food. It dissolves the starch and cellulose of the food, and fits it to soak through the walls of the alimentary canal, so that it can enter the system. The œsophagus is composed essentially of muscular tissue, and expands into a crop (or food receptacle), and then into a gizzard. This is provided with hard plates, that help to grind up the food, which, after being so ground up, is passed through another short tubular passage into the stomach. The walls of the stomach secrete a fluid resembling the gastric juice of the higher animals; this changes the insoluble proteid of the food into a soluble peptone, which is readily absorbed by the walls of the stomach and intestine. The stomach opens into the intestine, the upper end of which is connected with a number of tubular glands. These are supposed to represent the liver of the higher animals. The intestine ends in a chamber called the "cloaca," in which the waste matters are collected, and from which they are expelled through the anus.

In vertebrates, the nervous system is placed dorsally, and the circulatory and respiratory systems ventrally, in relation to the alimentary canal. These positions are exactly reversed in insects, the nervous system being placed ventrally, the circulatory and respiratory systems dorsally, the alimentary canal being still placed between them. It has, however, been shown that this difference is more apparent than real, the dorsum of the insect being really analogous with the venter of the vertebrate, but the position of the limbs is reversed.

In the upper part of the body, and directly under the dorsal integument, is a longitudinal organ, somewhat like a long tube, which is known as the dorsal vessel. This corresponds with the heart of the vertebrates, and it consists essentially of only one chamber, although this is divided into 8 or 9 sacs, the latter, with openings along the sides, called ostia. It is composed chiefly of muscular tissue, and is connected with the roof of the body by short stout muscles, which keep it in position. It opens towards the head into a kind of arterial trunk. As the dorsal vessel contracts from behind forwards, the blood, which consists of plasma, or fluid, and colourless corpuscles, is driven forward into the trunk. The latter subdivides into smaller vessels, which are soon lost, the walls gradually becoming inseparable from those of the ordinary lacunæ, or depressions found between the tissues, and which are lined in many places with epithelium. As the blood passes through these lacunæ, it is brought into contact with the tracheal branches and aerated. At the same time the nutritious parts of the food, which soak through the walls of the stomach and intestine, enter the blood in the lacunæ found near these organs.

The great difference that exists between the blood of insects and that of vertebrates, is such that one feels that it is a great mistake to call two so dissimilar fluids, with different functions, by the same name. The blood of insects varies with the species, sometimes even with the various stages of the same insect. Its function is to carry the nutritious matters to the tissues, and to feed, as it were, the tissues it bathes. It is frequently filled with somewhat crude fatty matters, and Gräber calls it "a refined or distilled chyle."

Beneath the dorsal vessel, a fine membrane is stretched in such a manner as to separate the dorsal vessel from the surrounding organs, and, at the same time, leave a cavity around the dorsal vessel itself. This cavity is called the pericardial cavity or sinus. The membrane itself is incomplete, and when certain delicate muscles connecting it with the body-wall contract, they pull it down tightly upon the tissues below, and this, of course, at once increases the size of the sinus. The tissues thus pressed upon are full of chyle and blood, and the fluid is squeezed from these structures through the incomplete membrane, into the pericardial chamber, and from thence it re-enters the dorsal vessel again. The number of contractions of the dorsal vessel varies remarkably. They may amount to as many as a hundred per minute; they may cease altogether without death ensuing. It is recorded as pulsating from 48 to 52 times per minute in the larva of *Triaena* (*Acronycta*) *psi*, and 44 times per minute in the larva of *Brotolomia meticulosa*.

In spite of the fact that Swammerdam, Réaumur, Bonnet, De Geer, and others, all speak of blood-currents, of fluids moving in the body, of pulsations of the heart or dorsal vessel, and of circulation, Kirby and Spence record their emphatic opinion that there is no circulation in insects. The idea of circulation taking place in the lacunæ of the tissues does not appear to have suggested itself, and the early authors appear to have thought that definite tubes with definable parietes were necessary for circulation. Bowerbank, and others, placed the matter beyond dispute, and it is only necessary to refer to it here, because many entomologists still seem inclined to accept the statement of Kirby and Spence.

The fat-body is a very prominent part of the structure of the lepidopterous larva. It consists of fat masses of various size, loosely connected together, and enveloping most of the organs. It varies in colour and appearance in almost every species of insect, and appears to consist of a reservoir of reserve material, which increases in the larval stage, when the insect is busily engaged in feeding, and upon which the insect can draw in the future, when it is unable for a long period to take food, *e.g.*, such periods as occur at each exuviation of the larval skin, and also at the more exhausting periods of metamorphosis. It must also be looked upon as a storehouse on which the insect can draw when in the more quiescent pupal stage.

The respiration of the Lepidoptera has been partly dealt with in the preceding chapter, and we have seen that air is conveyed into all parts of the body by means of the tracheæ. The tracheæ are elastic tubes, held open by an inner chitinous layer, and they are all intimately connected. Large tubes connect the spiracles longitudinally, others pass from one side of the body to the other, whilst a set of tracheæ in the lower part of the body is connected with another set in the upper part by ascending tubes. These main branches give out small branches, which fork in all directions, and hence the body is supplied most plenteously with air. The tubes have a white glistening appearance, and hence can be detected in a freshly killed insect without difficulty. [In insects of strong flight, there are air-sacs connected with the tracheæ, and capable of holding sufficient air to decrease, when distended, the specific gravity of the insect.] The finest tracheal tubes are supposed to penetrate cells, but it is not known whether they terminate with open or closed extremities.

The activity of the respiratory system of the Lepidoptera may be readily surmised from the rapidity with which they are affected by agents, such as ammonia or chloroform, yet the exact manner in which breathing is carried on is unknown. Rapid movements of contraction and expansion of various parts of the body, accompanied by the opening and shutting of the spiracles, are often observed, and are supposed to be respiratory, but it is generally believed that, although the tracheæ must supply the tissues with oxygen, they do not carry off the carbonaceous waste from the tissues. Many consider that some of these waste matters are passed from the skin, and this is more probable than any other explanation yet offered. It is well-known that caterpillars, shut up and with insufficient air, throw off waste products most freely from the skin, the process being popularly known as "sweating." Some entomologists consider that the skin is built up from within, and since chitin is composed largely of carbon and nitrogen, it is possible that certain of the waste matters may be used in the formation of chitin, and finally passed off when the larva exuviates or casts its skin.

The Malpighian tubes, a number of coiled filaments found in the dorsum of the larva, used to be considered analogous with the liver of vertebrates, and were supposed to secrete a substance somewhat analogous with bile. They are now known to be excretory organs, and to remove various compounds from the system. It is not yet known how the tubes are emptied, but the material contained in those of some of the Lasiocampid and Saturniid moths, is supposed to be mixed with the silk of the cocoon, and to be used for the purpose of hardening the latter. It certainly seems to be so used in *Malacosoma* (*Clisiocampa*), *Eriogaster*, etc. The substance excreted is generally in the form of oxalate of lime, or some allied compound.

Lepidoptera, in common with many other insects, have a very complicated nervous system, which may be conveniently considered as consisting of three divisions: (1) The cephalic system. (2) The ventral or ganglionic chain. (3) The accessory sympathetic system. These divisions are, of course, very intimately connected.

The cephalic system consists of two masses. One is large, and placed above the œsophagus, and, hence, is termed the supra-œsophageal ganglion; the other is smaller, and placed below the œsophagus, and, hence, is termed the infra-œsophageal ganglion. These are united with nerve fibres, passing round the œsophagus, and forming what is often termed the œsophageal ring or collar. These cephalic ganglia are often spoken of as the brain, and, in these, the nerves which supply the eyes, antennæ and tongue originate.

The ventral chain consists of a series of ganglia. These are small masses of nerve substance, placed longitudinally along the ventral side of the insect. They are arranged in pairs (theoretically one pair in each segment, although often various pairs of ganglia are united), and the ganglia are connected with the ganglia preceding and succeeding by longitudinal nerve fibres or commissures. From these ganglia the motor nerves of the body are distributed to the muscles in the various parts of the body. In the larva of *Tischeria angusticolella*, the paired ganglia are very distinct in each of the thoracic segments, and in the abdominal segments 1-6. Scudder says that they are usually found in the lepidopterous larvæ as far as the 7th abdominal segment, in which there is a pair of ganglia, and here the nervous cord terminates. The nerve ganglia of *Tischeria* are placed very nearly to the front of each segment. [In the lepidopterous imago the union of the ganglia in adjacent segments is sometimes very complete. In different families there appear to be sometimes two, at other times three, thoracic ganglia, but always four abdominal ganglia, with the exception of the Hepialids, which appear only to have three.]

The sympathetic system consists of a median nerve cord, dilating at intervals into ganglia, and placed above the ventral system, with the commissures of which it is connected by nerve fibres. The nerves from this system are distributed to the various organs of the body connected with alimentation, circulation and respiration.

It must be remembered that, although apparently so different, the development of the nervous system in the embryo is analogous with that in vertebrates, and that, although the nervous system of insects is apparently ventral, whilst that of vertebrates is dorsal, the ventral part of an insect corresponds with the dorsal part of a vertebrate, *i.e.*, in reality, opposite parts of the body are placed ventrally in insects and vertebrates respectively, owing to the limbs being turned in opposite directions in the two cases.

It used to be a generally accepted belief that the lepidopterous larva had no sexual organs, and this, in spite of the fact that Réaumur, a century and a half ago, stated that he had discovered eggs in the larva of *Porthetria dispar*, and that Malpighius found them in the larva of *Bombyx mori*. The reproductive organs, however, are not difficult to observe in some larvæ, and can usually be obtained by a little careful dissection. The testes and ovaries are placed just beneath the skin of the 5th abdominal segment. They exist in pairs, one on either side of the dorsal vessel, just above the position of the alimentary canal. The testes form two lobes of a not very distinctly reniform shape, whilst the ovaries, which are only to be seen with a lens, and then in comparatively few species, are much smaller, and consist of tubes. The testes are generally much more readily observed than the ovaries, being, usually, yellow or brown, and may be seen distinctly in the larvæ of those species which feed internally, or which have fairly transparent skins. Weniger detected the blind terminations of the ducts from the sexual organs in the larvæ of *Antheraea yama-maï*, *A. pernyi*, *Actias selene* and *Samia cecropia*, "on the underside of the last segment that bears a spiracle" (8th abdominal). In the female of the first of these species is a black blotch, with a yellow central spot, whilst in the male is a similar black blotch, with a dark green central spot.

Herold represented, as long ago as 1815, the changes which the essential reproductive glands undergo in the larva and succeeding stages of *Pieris brassicae*, but up to the present time there appears to have been no external openings, in connection with the sexual organs, discovered in any lepidopterous larva. Certain statements which have been made on this subject are mentioned here only in order to draw attention to them, in the hope that they will be disproved or confirmed. De Geer states that the brown larvæ of *Triphaena pronuba* produce males, and the green larvæ, females. Doncaster says that the same larval colour distinction, as to sex, holds good in the Satyrid butterflies. He also states that the male larvæ of *Orgyia antiqua* and *O. gonostigma* have yellow dorsal brushes, the female larvæ, brown. Suckow distinguishes male *Dendrolimus pini* larvæ from female larvæ: (1) By the smaller size. (2) By the lighter, almost smoky-grey colour. (3) By a black-brown band situated beneath the second pair of prolegs. (This band is said to be only obscurely marked in the female).

Jackson says that the larval ovaries are situated in the 5th abdominal somite, and close to the dorsal middle line. Their proximal or attached extremities are approximated, and they diverge from one another posteriorly. The colour gets deeper during the quiescent period preceding pupation. Four opaque white lines, the future ovarioles, traverse the larval ovaries lengthwise and converge towards their hinder extremities, from which the larval oviducts spring. The latter are very delicate filaments, and difficult to make out.

Bessels gives the following table of species in which the larval testes and ovaries are dissimilar in colour:—

SPECIES.	OVARY.	TESTIS.	FAT-BODY.
Porthetria dispar ...	yellow ...	flesh-red ...	white
Cosmotriche potatoria	yellow ...	yellow ...	white
Deilephila euphorbiae	yellow ...	reddish ...	yellow
Pieris brassicae ...	yellow ...	violet ...	white
Cossus ligniperda ...	white ...	white ...	white

Jackson adds that, in these particulars, the larvæ of *Sphinx ligustri* and *Phalera bucephala* agree with *Cossus*. In *Pieris brassicae* the fresh fat-body posteriorly to the 6th segment is greenish or olive-yellow, anteriorly to it opaque yellow or green on the dorsal aspect, but on the ventral aspect white. The fat-body of the larva of *Vanessa io* is yellow, and becomes orange in the pupa (*Trans. Linn. Soc. Lond.*, Zool., vol. v., p. 159).

With regard to the point of development reached by the sexual organs in the lepidopterous larva, it would appear that they have developed as far as that reached by the adult (imago) Ephemerid (May-flies). In the imagines of the Lepidoptera, the two oviducts unite, and form a single tube down which the egg passes. In the adult Ephemerid, the two oviducts remain separate. In the larva of *Vanessa io*, the oviducts are separate, as in the Ephemerid imago, but by the time that the butterfly is matured, the oviducts have united to form a quite typical ovipositor. Such a line of evolution, however, suggests that the oviduct of the Lepidoptera passed through a stage similar to that which is to be observed in the *Ephemera* at the present time, before it reached its present high stage of development.

CHAPTER VII.

THE VARIATION OF THE IMAGINES OF THE LEPIDOPTERA.

THE variation in the colours of insects is so patent to every observer of these interesting creatures, that there is no need for one to attempt to show that variation exists. Superficially examined, we find that the individuals of a given species are very similar to each other, yet the eye of an expert sees minute differences in these individuals, and he knows that just as no two men or women are exactly alike, so no two insects are, in any of their stages, precisely similar. Variation is general throughout every stage of an insect's existence, *i.e.*, in the egg, larval, pupal and imaginal stages.

Every living animal seems to exist for two distinct purposes—to eat and to be eaten. Nature provides everything with a means of offence or defence, or both. Among insects, weapons of offence are rare, and, generally speaking, their safety lies rather in their defensive characters. These are usually of the most inactive kind, and consist essentially of various disguises, by means of which, when in repose, they bear a strong resemblance to the various objects on which they rest—the bringing into harmony, as it were, the colours of insects with their environment, so that they may agree in tint with the object on which they rest, or that they may bear a close resemblance in hue and shape to some object common upon their resting-place. This bringing into harmony presupposes the possibility of a change in the colours of insects, in order that they may respond to the varying conditions under which they may be placed, and in which they have to live. This further presupposes a plastic condition of the colours themselves, otherwise they would not be able to respond to differences of environment. These differences are so many and so varied, that we find variation in the colours of insects occurring under a multitude of different conditions, and to be presented in a variety of ways. In these notes we shall confine ourselves to the brief consideration of a few of the principal phases of variation exhibited by the imagines of certain Lepidoptera.

The colours of the wings of butterflies and moths are due largely to the scales found on the wing membrane, and, in a less degree, to the colours of the wing membrane itself. The scales themselves are hollow chitinous cells, united by a ball and socket joint to the membrane of the wing. They are epithelial expansions, which, having attained the size and shape peculiar to the species, become hardened externally by a chitinous deposit. In the process of their development, they go through a regular series of changes. They are at first transparent, then they become whitish, then a secretion from the pupal hæmolymph, called "pigment factor," enters the scale, and it becomes yellow; lastly the pigment-factor is elaborated, and the scales assume the coloration that they will have in the wing of the perfect insect. These changes, of course, all take place in the pupa, before the imago emerges, and no development takes places afterwards; any change that then occurs being due to exposure, the influence of light, etc. There can be no active response, whatever, in the perfect lepidopterous insect, to any change of environment, *i.e.*, no change can occur in its coloration once the insect has emerged from the pupal state.

Ordinary white light can be decomposed. Popularly, we say, it can be broken up into a number of differently coloured lights—red, orange, yellow, green, blue, indigo and violet, and we call these the colours of the solar spectrum. These colours, in fact, represent the effect produced on the optic nerve by the variable rate of vibration of the constituent waves, of which white light is really composed. If a substance has the power of absorbing some of the light waves, from the white light which ordinarily falls upon it, and of reflecting others, only the reflected portion can possibly affect the optic nerve. If the red rays only be reflected, then the colour of the substance appears to us to be red, if blue, then the colour appears to be blue, and so on. Substances which are thus able to select certain light waves for absorption, and to reflect others to our eyes, are termed pigments, and the fact that most scales of Lepidoptera contain substances that can do this, causes us to term the colours thus produced pigmentary colours.

But colours are also obtained by the refraction, interference and diffraction of white light. Scratched and striated surfaces diffract light. Diffraction breaks up the bent part of a ray of light into its component parts, and, dispersing the waves, gives, on the edge of each bright space between the slits or striations, a fringe of colour. The exposed surface of the scales of many Lepidoptera are striated, both longitudinally and transversely, hence these produce surface colours by diffraction. One of the best-known examples of this kind of coloration in British insects is the purple of the male of *Apatura iris*. Such colours as these are usually termed in entomological magazines, non-pigmentary colours.

Having thus briefly stated the phenomena by means of which, practically, all the colours of the scales of butterflies and moths are derived, we see that the colours are due either to the selective power of the pigment contained in the scales or membrane of the wing, or they are due to the peculiarities of structure and form of the scale.

We have already stated that variation is general in all insects, no two butterflies or moths of the same species being exactly alike. Sometimes this general variation in a particular species is so marked and conspicuous, that the most casual observer notices the fact. Such species are then said to be polymorphic. In a less degree, however, it may be accepted as a general fact that all species of insects are polymorphic.

The enemies of butterflies and moths are very numerous—insectivorous birds, reptiles, mammals, other insects—and as they have practically no weapons of offence, their safety lies in their resemblance to their surroundings. Danger, to them, is probably more real when they are at rest, hence, when at rest in a natural attitude, one is at once struck by the marvellous resemblance which most butterflies and moths bear to the surface (or to some common object on the surface) on which they rest. With the initial general variation which we have observed to occur in all insects, it is pretty certain that some individuals will be more readily detected than others, some peculiarity of tint, some mark or spot of colour, maybe, rendering them a little more conspicuous. These will fall a more ready prey to the enemies that are searching for them, and they are, as a rule, the first eaten. Those that are best protected are most likely to be left, the laws of heredity step in, and a larger proportion of well-protected specimens results in the progeny. Of course, the general variation which must exist in all broods, and between all individuals, the tendency to atavism, and similar causes, will always result, even then, in producing some less favoured individuals. Still the general result will be that a well protected race, suited to the particular environment by which it is surrounded, will be developed.

It is evident, when we consider the different habits of insects, that the particular habit and environment of each species, will determine the main general lines on which the variation of the species will proceed. Butterflies sit with closed wings, hence it is the undersides of butterflies that are then exposed, and, therefore, the undersides take such form, colour and markings, under the influence of natural selection, as will best protect the individual, *e.g.*, the marbled green and white underside of *Euchloë cardamines*, which rests on umbelliferous flowers, the dark undersides and jagged wing margins of the Vanessids, which hybernate in hollow trees, and exactly resemble dead leaves, when at rest. Then there are the "reed" moths, which, belonging to many different super-families—NOCTUIDES, LIPARIDES, CRAMBIDES, TORTRICIDES, TINEIDES, ZEUZERIDES—sit by day on the reeds, their bodies closely appressed to the reed, their wings folded partly round it, so that each insect represents a gentle swelling of the stem, culminating in an apparent node on the culm, where the insect's head is situated. The colour of all these moths is a very pale wainscot—the tint of a dead or dying reed—with very fine longitudinal striations, agreeing absolutely with the colours and markings of the reed stem. Another large group of moths—chiefly GEOMETRIDES—have the habit of resting on tree-trunks, where their general grey hue, marbled with transverse wavy lines, gives them a very close resemblance to the bark on which they rest. Again, in hilly and mountainous districts particularly, a large number of species rest upon the rocks, when their colour usually assimilates closely to that of the rocks upon which they rest, and these, too, are generally covered with transverse wavy lines, which cause them to be very inconspicuous so long as they remain immovable upon their resting-places. Some moths that rest on walls, rocks, or trees, are marked with green and yellow. Such are the species of *Polia*, *Bryophila* and *Cleora*, *Larentia flavicinctata*, and others. These, when at rest, are scarcely to be distinguished from the lichens which grow upon the rocks on which they sit. Then there are the green and yellow moths—the Emeralds, Thorns and Sallows—which hide among the leaves of trees, or the lower herbage, and resemble, in hue, dead or living leaves so exactly, that they are scarcely to be detected, whilst those that rest among the roots of grass and low herbage, generally, are of various shades of grey, or buff, or brown, which make them very inconspicuous near or upon the surface of the ground.

It is quite clear that, in all these general cases, and in many special ones, natural selection has produced races, particularly well suited in the case of each species to the environment in which it is placed, also that the more conspicuous individuals become a ready prey to enemies, whilst inconspicuous individuals are more often left to carry on the race.

One of the most interesting special phases of variation exhibited by British Lepidoptera is that of melanism and melanochroism, the former term being applied to those individuals which exhibit a tendency to develop a greater proportion of black in the ground colour than is exhibited by the type, the latter, when the ground colour is intensified, but not in the direction of becoming blacker. The ab. *doubledayaria* (popularly known as the "Negro") of *Amphidasys betularia* may be cited as an example of the melanic class. The ab. *ochracea* (of a deep ochreous or buff tint) of *Spilosoma menthastri*, which is white in its typical form, is a very good example of those insects which exhibit melanochroic tendencies. These tendencies are noticed to be much more generally developed in species that rest on fences, the trunks of trees, the faces of rocks, or on the ground, than in other species. It may, of course, be assumed that those usually found upon fences were originally confined, more or less, to tree-trunks, and that the influences acting upon one are equally potent on the other.

It has been observed that, in a great number of species of moths that rest on fences and tree-trunks, and are more or less abundant in the London district, the individuals are darker in colour than those of the same species, captured a few miles outside the metropolis. This is clearly observable in *Triaena psi*, *Hemerophila abruptaria*, *Acidalia virgularia*, *Eupithecia rectangulata*, *Melanippe fluctuata*, *Boarmia gemmaria*, *Hybernia defoliaria*, *H. marginaria*, *H. leucophaearia*, *Oporabia dilutata*, *Diurnaea fagella*, *Tortrix podana*, *Hedya ocellana* and many other species.

There can be no doubt that in the suburbs of London, fences and tree-trunks are generously covered with soot. (Those who have greenhouses, and attempt to keep the white paint clean, will understand how completely they are covered). The tree-trunks have become darker during the last fifty years, and the depth of colour is gradually increasing in what were then suburban districts. The pale grey and ochreous specimens of the insects just named used to be well protected on their then clean resting-places. Such specimens are now exceedingly conspicuous when they occur, which they only occasionally do, for the selection of the darker specimens for preservation by nature, has resulted in the permanent darkening of the race. But it is in the manufacturing districts—in Yorkshire, Lancashire, Cheshire, Derbyshire, Notts, Staffordshire, South Wales, etc.—where thick smoke is poured from numberless chimneys, and where the fences, tree-trunks, and even the surface of the ground are begrimed with soot, that the most marked cases of what may be termed protective melanism occur. There we get the "Negro" aberration (ab. *doubledayaria*) of *Amphidasys betularia*, the ab. *nigra* of *Tephrosia crepuscularia (biundularia)*, the ab. *fuscata* of *Hybernia marginaria*, the ab. *obscura* of *Epunda viminalis*, the ab. *nigra* of *Boarmia repandata*, whilst many other species give absolutely black aberrations, which are rarely observed elsewhere. These black aberrations, it is well-known, have practically come into existence during the last half-century, and their range is rapidly extending. So completely, too, are many of these dark aberrations supplanting the type that, in some localities, the pale typical forms are almost unknown. These moths are nearly all essentially grey—that is, black and white—in their typical forms. The gradual darkening of the tree-trunks, etc., by the deposition of soot, has resulted in the better protection of the darker specimens, and hence their better preservation, and, as we have just hinted, the trunks and fences have become so blackened that, in some districts, the absolutely black specimens comprise the best protected form of the species.

Parallel, if not absolutely identical, with this form of melanism is that exhibited by those species that rest on rocks. Certain Alpine species exhibit this form of melanism in a most marked manner, both in the mountains of Europe and N. America. Certain species that rest on peat are black, wherever they may be found, and however different may be the meteorological conditions of the various districts they inhabit. On the peat bogs in the New Forest, *Gnophos obscurata* is black, so also is it on the dark rocks of Perthshire; in Sussex, on the chalk, it is white, and the response of this moth, in ground colour, to the colour of the rocks on which it rests, is very remarkable. The black specimens found on peat in the New Forest, and on the dark rocks of Perthshire, have a similar melanic appearance, the colour evidently having been induced under such entirely different environments, by a similar process of selection. But it is in the wet, mountainous, and western districts of the British Islands, where the rocks are blackened with moisture, and, even in summer, do not lose one lot of wet until they have received another, that we find the most striking cases of melanism. Thus, on the coasts of Scotland, the Isle of Man and Ireland, we find black races of *Agrotis lucernea*, an insect that is quite pale on the chalk rocks of the Isle of Wight. In the Isle of Man the dark ab. *manani* of *Dianthoecia caesia*, quite unlike the mottled Continental type, occurs. The aberrations *nigra* and *infuscata* of *Xylophasia monoglypha*, an insect which rests upon the ground, are found in all districts where the rocks are naturally dark, or where there is a heavy rainfall. On the west coast of Ireland, melanic forms of *Camptogramma bilineata* are found resting on the rocks, and contrasting greatly with the beautiful golden specimens that hide on the undersurfaces of leaves in our gardens, whilst the aberrations *suffusa*, *intermedia*, *ochrea* and *obliterae* of *Dianthoecia conspersa* are found on our northern and western coasts, and respond so perfectly to the rocks upon which they rest, that the professional collectors can tell almost the exact localities in various parts of the Shetlands and Hebrides, from which individual specimens have come. In Shetland, again, the little whitish *Emmelesia albulata* of our southern pastures and meadows, becomes of a deep unicolorous leaden colour.

In all these cases, moisture plays an important, if indirect, part. In the first case, it brings down, in manufacturing districts, the soot in the air, which, when evaporation takes place, is left behind and forms a coating on the tree-trunks, fences, or rocks on which the insects hide. In the second, it permanently darkens the rocks in mountainous districts, and more or less so in the western areas, where there is a heavy rainfall. It makes, therefore, the work of natural selection in the direction of producing melanic aberrations exceedingly easy. This aspect of melanism has been already worked out at considerable length.*

There have been occasionally general statements made to the effect that insects from high latitudes are usually melanic. This is so, if only the coast districts and areas with a heavy rainfall be taken into account; but if the open areas of high latitudes be considered, we find that, although there is a general suffusion of markings and a tendency to ill-developed pigment, due probably to the extreme conditions under which development takes place, yet, as a rule, melanism is rare. Mr. Merrifield has, however, shown us two cases in which temperature tends to produce melanic forms. These are remarkable from the fact that the exposure of the pupa to a low temperature in one case, *Eugonia polychloros*, produces a melanic form; in the other, *Chrysophanus phlaeas*, exposure of the pupa to a high temperature produces a somewhat similar result. These, and parallel cases, are not difficult of explanation.

---

* Tutt, *Melanism and Melanochroism in British Lepidoptera*, 1891.

The pupæ are exposed to the low and high temperature respectively, at the period when the scale-pigments are undergoing differentiation in the scales, from the hæmolymph of the pupal blood. There is a point at which this elaboration is carried on at a normally healthy rate. At a temperature considerably above or below this normal point, the pigment is developed abnormally, maybe never reaches its normal condition (chemically), or, maybe, overshoots it. In either case, abnormal conditions are produced, and, in these two instances, the abnormality results in a melanic appearance of the insects.

There are, of course, other forms of melanism which probably have nothing in common with the cases already cited. One of these is well represented by the ab. *valesina* of *Dryas paphia*, by the ab. *suffusa* of *Argynnis aglaia*, etc., which are probably survivals of the old form of the Argynnid female (*vide*, *Entom. Rec.*, i., pp. 29-31).

The production of albinism in Lepidoptera is not of very frequent occurrence, still it occurs sufficiently often for the phenomenon to be worthy of mention. It occurs in a more or less perfect manner in species that rest on the ground, and which vary in tint according to the colour of the soil upon which they rest. In *Gnophos obscurata*, almost purely white specimens are often found in districts where the insects rest upon the bare chalk, and the same is true of *Eubolia bipunctaria*, which has almost similar habits. These insects are, in their typical forms, grey, *i.e.*, their scales are—some black, others white. The process of natural selection has weeded out the more conspicuous (darker) examples in these localities, until a more or less white race has been produced. It may be urged that these are not truly albinic specimens, but they are exactly parallel in their mode of development with some of the melanic forms to which we have previously referred.

True albinic specimens, we take it, are such as those of *Callimorpha hera*, *Triphaena pronuba*, *Catocala nupta*, and other species that have been recorded, in which the yellow or red pigment has failed, and the scales have become white. In dealing with these specimens it is evident we have a result based directly on physiological processes, for the scales contain no pigment, the normal elaboration of the hæmolymph material having been largely or entirely suspended and the scales filled with air. In our collection are specimens of *Hemerophila abruptaria* and *Hybernia aurantiaria* exhibiting this phenomenon, and we believe that the specimens of *Sesia culiciformis* in which the normal red (or yellow) pigment of the abdominal belt is occasionally white, afford a similar instance.

Not very different is the cause which gives rise to the xanthic aberrations, which are often included under the same head. In a paper, "The genetic sequence of insect colours,"* we long since pointed out that many instances of white coloration were due to an unstable pigment in the cells, and that certain instances of black coloration were also the result of highly differentiated pigment. These "whites" are very rapidly changed to ochreous or buff under the influence of ammonia, but regain their chemical equilibrium quickly on exposure to the air. The embryonic scale is apparently filled with a secretion from the hæmolymph, which, in its first stage, becomes of a milky-white coloration, afterwards changing rapidly to buff and ochreous-yellow, the further coloration of the pigment giving rise to the special coloration of the scales. Xanthic patches, sometimes extending to a whole wing, at others to the whole insect, are exceedingly common in Satyrid and Argynnid butterflies, and appear to be due to an arrest of the development of the pigment in the whitish or ochreous stage.

---

* *British Noctuae and their Varieties*, vol. ii., pp. i.-xvi.

The instances of protective resemblance already referred to, remind us at once of the particular case which has been brought under our notice by Wallace, Weismann, Nicéville, and others, *viz.*, that affecting the "leaf butterflies" of the tropics. In the instances we have hitherto considered, the resemblance of the insect has been to the surface upon which it rested, gaining its protection by its resemblance to that surface as a whole. In the case of the "leaf butterflies," the resemblance is to a special definite object, *viz.*, the leaf of the particular tree on which the insect rests. These butterflies are Nymphalids, and belong to the oriental genus *Kallima*, the Indian species—*paralekta*, *inachis*, and *philarchus*—being nearly four inches in expanse, while the African species, *K. rumia*, is smaller. These butterflies are conspicuous objects when flying, but when they alight upon a twig, the wings raised over the back, and the fore-wings thrown well forward, the pattern and colour of the undersurface are such that they make a perfect resemblance to a leaf. The mid-rib consists of a coloured stripe crossing both wings, which, taking its rise at the apex of the fore-wing, is continued over the hind-wing, and terminates in a tail-like extension of the latter, the extension just reaching the twig, and thus resembling the petiole of a leaf.

But the similarity of colouring between some of the unprotected Pierids and the nauseous Nymphalids, is, perhaps, more remarkable. It is well known among entomologists that many of the latter are specially protected from the attacks of birds, and other insect-eating animals, by the production of various scents, which make them distasteful and objectionable as articles of food. On the other hand, the Pierids—of which our common white and yellow butterflies are good examples—appear to be particularly subject to the attacks of numerous enemies. Bates, Trimen, and other observers have noticed that in the tropics, the Pierids, flying with the Nymphalids, frequently lose the ordinary Pierid coloration and type of markings, and become orange-coloured, and marked on the same general lines as the common Nymphalids. So similar are the colour and markings in some instances, that even specialists have been, for a time, deceived, and have failed at first to recognise them, not only as belonging to different families, but even as distinct species. That this similarity served the purpose of protection to the Pierid was first propounded by Bates, and it soon became generally accepted as an explanation of the facts, that the Pierids, owing to their similarity to the nauseous Nymphalids, were less likely to be attacked by birds and other insectivorous animals, which had learned by experience that insects of a certain colour were objectionable as articles of diet.

We frequently find that when the sexes of a given species vary much in habit, there is considerable difference in the colour, and less often in the markings, of the sexes. Sometimes, too, there is considerable sexual diversity when the habits are very similar. Many species have the males brilliantly coloured in comparison with the females; frequently the sexes are almost identical in tint, but the instances, among insects, in which the female is more brilliantly tinted than the male must be exceedingly rare. Scudder mentions one South American genus where this is so; perhaps *Zephyrus quercûs*, *Z. betulae* and *Thecla ilicis* may also be cited, but the cases are comparatively few. Darwin considers that the excessive beauty on the part of the males is due to sexual selection, the females having, through a long period of time, selected the more attractive males. He further thinks that the various forms of beauty originated as casual variations, and that the special characters were then intensified by the selection exercised by the female. Wallace, on the other hand, considers that the sober colours of female insects are due to natural selection, and have been the means of their preservation, since the operation of natural selection has eliminated those individuals of the latter sex that are most gay, and, therefore, conspicuous to their enemies. Darwin starts from inconspicuous forms, from which he derives the conspicuous ones, whilst Wallace starts from conspicuous forms, and from them derives the inconspicuous ones. We have already* shown that, among the Lepidoptera, facts distinctly bear out Wallace's view. There is no need to give any special examples of sexual dimorphism, for, as a matter of fact, it would be difficult to find among our British lepidoptera many species that do not exhibit this phenomenon to a greater or less extent.

Another marked form of variation that occurs in certain species is that known as seasonal dimorphism. In those countries which have a very distinct difference between the summer and winter temperatures, certain species produce one form of the imago in the spring, after the pupa has been exposed for some months to the climatic conditions of winter, and another form of the imago in the early autumn, after the pupa has been exposed for only a few weeks, or even days, to the climatic conditions of summer. The differences between these two broods are usually marked in two ways—(1) Size. (2) Colcur. It frequently happens that the summer or autumn-emerging brood is the smaller, and this is undoubtedly due to the difference in the quantity of food eaten, since the larval state of this brood lasts a much shorter time than that of those that emerge in the spring, the larvæ, indeed, often missing a moult in order to come to maturity more quickly. The difference in colour is probably due, in different species, to two distinct causes: (1) The less energy at disposal for the purpose of pigment formation in the quickly-feeding individuals. (2) The direct influence of the temperature on the pigment during its formation.

Standfuss asserts (*Causes of Variation*, etc., p. 5) that, in some experiments that he made on lepidopterous larvæ, the more the period of larval feeding was shortened by the raising of the temperature, the better marked was the reduction in size of the imago. This was the regular, and almost invariable result. A pair of *Eutricha quercifolia*, of which the male measured 58 and the female 89 mm. across the wings, produced offspring of which, after a sojourn of 70-85 days in the larval, and 12-15 days in the pupal, condition, the males measured only 35-37 and the females 36-39 mm. across the wings. *Arctia fasciata*, male 46 mm., female 48 mm. across the wings (from pupæ collected in the open air), produced three females, measuring 36-39 mm., after a larval stage of 68-87, and a pupal of 15-20 days. *Callimorpha dominula* var. *romanovi* ♂, of 59 mm. and *C.* var. *persona* ♀ of 55 mm., gave rise, after 65-71 days of larval feeding and 14-19 days in the pupal stage, to a form measuring only 35-38 mm. across the wings, in more than a dozen examples.

---

* *British Noctuae*, etc., vol. iii., pp. xvii. *et seq.*

Although in the following experiments no hybernation of the larvæ occurred, yet, in contrast to the instances just given, individuals of *A. fasciata* were reared from eggs of the same pair as above, after 142-163 days of larval, and 25-31 days of pupal, existence, which measured 55-57 mm. in expanse; and eggs of *Dendrolimus pini* (male 59 mm. and female 74 mm.), yielded descendants expanding 65-68 mm. in the male, and 84-86 mm. in the female, after 150-172 days of larval feeding and 25-37 days in the pupal condition.

In tropical countries where there is less marked difference in the temperature at various seasons, but where there is a marked difference in the rainfall, *i.e.*, in countries where the seasons are known as "wet" and "dry," we get what are known as "dry seasonal forms" and "wet seasonal forms," *i.e.*, that a larva that feeds up during the wet season produces an imago different from that produced from a larva of the same species that has fed up during the dry season. The difference sometimes occurs in the shape of the wing, sometimes it is a difference of colour, more often of ocellation. So marked are the differences, that the forms have, in almost all instances, been described as distinct species, but Doherty* succeeded, in the early part of the dry season, in the Island of Sumbawa, in breeding both *Melanitis leda* and *M. ismene*, from the eggs of *M. leda*, the two having been previously considered to be distinct species. This was done by separating a batch of larvæ of *M. leda*, and rearing one part under natural conditions, which produced, in due course, the dry season form, *ismene*, the other part being reared in a box, in which a wet sponge was kept, in order to retain a damp atmosphere. The imagines produced from the larvæ reared under the latter conditions were the wet season form, *M. leda*. De Nicéville, Marshall, and others, have also reared the one form of various species from eggs laid by another.

It has been clearly shown that temperature and moisture are two important factors in bringing about changes in the appearance of insects, *i.e.*, they act in such a manner as to exert a marked influence in producing variation. Our climate, of course, is not suitable for the production of "dry" and "wet" seasonal forms, as it does not afford the necessary conditions. It does, however, afford the conditions (although in a much less marked degree, than some parts of Continental Europe) for the production of "spring" and "summer" seasonal forms. Yet, since the action of moisture is so distinctly the predominant feature in bringing about the phenomena of "dry" and "wet" seasonal dimorphism, it must be conceded that moisture is an effective external factor in influencing the larval life in such a manner as to leave a marked impress on the resulting imago, and, in a moist climate like ours, there can be no doubt whatever that moisture is an effective external factor in determining variation, and that its general effect may be considerable, especially in those species which are not particularly affected by differences of temperature. On the other hand, temperature, possibly, has some effect as a factor in determining general variation in tropical countries, where it is, however, overshadowed by moisture. There are, probably, many other external factors besides "moisture and drought," and "high and low temperatures," which react on insects in such a manner as to determine variation, but these are the factors which have, at present, been most studied.

---

* *Journal of the Asiatic Society of Bengal*, vol. lviii., pt. ii., No. 1, 1889.

It may now be understood how a species, which exists under two very different environments, may produce two very different-looking imagines, so different, indeed, that their specific identity may be doubted. In the European fauna, this is well illustrated by species that exist both at the sea-level and also on mountains at a high elevation. The specimens of *Melitaea aurinia* from the plains are large, brightly coloured and ample-winged. Those from the mountains are small, ill-pigmented and narrow-winged, and are known as var. *merope.* That the factor that determines this change of size is food, we think very possible; that moisture and temperature have also something to do with the matter, is exceedingly probable. In this manner we get "lowland" and "alpine" forms of the same species; "northern" and "southern" forms similarly occur when a species is spread over several degrees of latitude; "eastern" and "western" forms, when specimens of a species caught in Western Europe are compared with specimens of the same species taken in Japan, and so on, differing often in size, shape or colour, or even all combined, and such races—known as geographical races—are often so distinct, that an expert can often tell at a glance the exact area or district from which the specimens have come.

The differences that mark these various races have an important bearing on the question of the origin of species. We believe that these differences are often correlated with variations that exist in the organism itself; sometimes, indeed, that they are the manifestations of such variation, and, if the conditions which are thus set up, and insisted upon by the environment year after year, be intensified, as, by the localisation and isolation of these races, they must be, the differences may often become permanent and acquire specific value. Differences in habitat—altitude for example—often permanently alter the time of appearance of the insect in the imaginal state, and thus the life-cycle is modified, the particular form is isolated, and its special features become, as it were, more and more fixed.

Thus far we have dealt only with the external manifestations of variation, as they are presented to our observation. Dixey has shown* us by what sequence of modifications the patterns of the wings of the Nymphalid butterflies have been formed from a more primitive type. He has also shown† us how the mimicking Pierids have attained the markings by means of which they so closely resemble the nauseous Nymphalids they mimic; but he has given us no clue as to the physiological processes underlying these changes.

Starting from the basis that every portion of an insect's wing has in it, from the germ, endless possibilities in the direction of variation, Weismann argues that utility determines the particular form of variation which will be acquired by the individual. We have already criticised,‡ at length, the details of this theory as to the origin of the protective coloration of the leaf-butterflies of the genus *Kallima*. We consider that the response to environment, as exemplified by the form, colour, shape, etc., of insects, is the outward expression of certain variable factors, which, arising within the organism, are directed as to what exact lines they shall ultimately take by the external conditions of life, *i.e.*, by utility. Weismann asserts that selection and utility originate the colour-patterns, which is true so far, and only so far, that actual colour-patterns do not exist until natural selection forms them out of the crude material at its disposal. It appears to us that there are two processes of selection engaged, before the ultimate production of any colour-pattern—(1) Selection (internal) among the biophors themselves, and dependent on the vital processes. (2) Natural selection (external), by means of which the variously coloured scales are formed into a pattern useful to the insect. The scale determinants, it seems, are subject to the same physiological laws as those of other organs. They are guided in the course of their development by various considerations, and whilst their general characters are due to internal forces, the special peculiarities of their arrangement are determined by natural selection; the particular variable factors which are useful for the preservation of the species being chosen for the purpose of building up the required patterns.

---

* *Trans. Ent. Soc. Lond.*, 1890, pp. 89 *et seq.* † *Ibid*, 1894, pp. 249 *et seq.*

‡ *Entom. Record*, etc., vol. viii., pp. 1 *et seq.*

The fundamental difference (apart from detail) between the old conception of selection, and that more recently propounded by Weismann, is that by Darwin, variations were considered to be fortuitous, and that selection had to wait for one of these chance occasions to occur, whilst Weismann considers that every portion of the organism contains within itself, from the first, an indefinite number of variations, some of which are almost sure to be in the direction required. Selection chooses those required, and, by the process of intra-selection, compels them, as it were, to overcome their competitors, and utilises them to produce those results which shall be of service to the organism.

At present, however, we have not got to the all-important factor in the study of variation, *viz.*, what are the physiological factors that decide which of Weismann's theoretical "determinants" shall be developed, and which be extinguished. Weismann tells us that, even in the germ, every part of an insect—a wing or a scale—however large or small, is composed of theoretical molecules called "determinants." These, by intra-selection, *i.e.*, by the competition of the molecules themselves, become non-existent as one absorbs the other, the predominant "determinant" finally deciding the nature and character of the part. He, therefore, considers that the particular form of the part, say a scale, is determined at a comparatively early stage of the insect's existence, *i.e.*, once the predominance of a particular "determinant" is assured.

Although the assumption of "determinants" enables us to explain certain phenomena, it does not bring us any nearer to the actual physiological activities which result in variation, nor does it explain to us how certain external factors result in variation. To say that a scale of an insect originally has in it the potentialities of becoming white, yellow or red, and that when the scale finally emerges red, to explain it by saying that the red "determinant" was successful over the white and yellow "determinants," does not help us much, and we unhesitatingly affirm that whether the scale is finally red, yellow or white, depends primarily on the conditions under which the organism carries on its existence.

Let us hark back a little. The wing of a butterfly is present in the embryo caterpillar before it hatches from the egg. The wing develops with the caterpillar, and with the pupa, and only ceases to develop with the stretching of the wing following the emergence of the perfect insect. Supposing the animal to have been supplied with a sufficient quantity of suitable nutritious food until the moment of pupation, to have been kept under the most perfect conditions of health throughout its larval and pupal existence, as a result we shall have an imago normal and perfectly typical in size, shape, colour and markings. On the other hand, let the food supply be short and innutritious, or the conditions under which it is reared unhealthy, or let the pupa undergo its final metamorphosis under adverse conditions, and we shall get a specimen small in size, stunted, crippled, maybe failing more or less in colour and modified in markings. Everyone who has bred insects in large numbers knows that these results are certain. These facts are only mentioned to show that these aberrations are outward manifestations of the vital activities of the insect.

Let us go a little more minutely into the subject. When the pupa of an insect is formed, the tissues (except those connected with the reproductive system) undergo histolysis. They are reduced and changed in character, and, from the material resulting in the degradation of the tissues as it were, new tissues are built up by the process of histogenesis. Among others, the scales are formed from epithelial cells, and they are filled with a secretion from the hæmolymph, known as "pigment-factor," containing the chemical constituents for pigmentation. The pigmentary matter is deposited on the inside of the scales, the hæmolymph secretion is withdrawn from the scales, and air takes its place.

The pigment in the scales of insects is of an excretory nature, *i.e.*, it is a product derived from the pupal blood, and, in a pupa, the larva of which has been reared under typically healthy conditions as to food and environment, this material will be normal; but if the pupa be weak, due to the unhealthy conditions of food and environment to which the larva has been subjected, will not the material from which the pigment is elaborated suffer with the other tissues, and will not this weakness tend to result in a departure from the normal, *i.e.*, produce an aberration?

If it be granted that these conditions are a possible cause of variation, it may readily be surmised that less pronounced changes in the life of a species may produce a less pronounced change in the general appearance, colour, and markings of the individual. It may be that the changes are severe enough to influence, but yet not severe enough to seriously affect, its health. If the change be permanent, then the outward manifestations of the changed vital processes will be exhibited permanently—possibly in the colour and markings. In this manner the differences existing between local races of the same insect living under different environmental conditions may possibly be explained. The predisposing factor to the change may have been food, moisture, heat, cold, or one of many other things, but the factor acting on the organism has brought about the result we see. If the result produced by these internal activities be such as to cause positive injury to the race, by rendering the individuals conspicuous, more palatable, etc., then natural selection will direct the variations that exist in the newly-formed race, into such lines, as will necessarily be of advantage to it.

But it may happen that a larva may exist under very distinctly favourable conditions until pupation takes place, and that, then, the pupa may be subjected to unusual conditions. We have already seen that the pupal period is that in which the wing-scales are entirely formed, and their contained pigment entirely elaborated. It is well-known that the pigmentary material goes through a regular (and for each species, fixed) genetic sequence before the mature colour is reached. It is evident, therefore, that changes of colour, due either to modification of scale-structure, or pigment, will be more readily effected in this stage than any other. The most powerful factor in bringing about a direct change has, thus far, been temperature. By exposing pupæ to temperatures to which they are not normally subjected, Merrifield has produced definite changes in the colours of certain species. These changes have been particularly marked in those species which have normally two seasonal—spring and summer—forms, varying in colour. Other species have, however, responded to the stimulus somewhat readily. No general results, however, have yet been deduced. In some instances (*Eugonia polychloros*), as we have already seen, a low temperature produces a darkening of the normal colour; in others (*Chrysophanus phlaeas*), a high temperature produces a similar effect. What is the nature of the difference in the pigment-factor of the scales of these two insects that makes them thus respond in such similar ways to different stimuli?

It is well-known that, within the area of distribution of a species, there is a certain part in which the environment is more perfectly fitted than in the remainder, by food supply, climatic conditions, etc., for the development of the species in its most vigorous form. Outside this limited area the species exists under less completely favourable conditions; the food-supply may partially fail, the climatic conditions, or other external factors of environment, may be less suitable, and, as a result, the insect produced may be less vigorous, less highly developed, either as regards size or colour, and may altogether show considerable difference from individuals developed under the most favourable conditions.

The darkness (or brightness) of *Chrysophanus phlaeas* seems to be due to climatic (temperature) conditions. It is well known that, as regards acclimatisation, some species succeed better in cold and others in hot, some in wet and others in dry, seasons. Whether this be due to the fact that some insects have spread to us from more northern, others from more southern latitudes, or to other causes, it is rendered highly probable that the same amount of heat may act prejudicially on one insect and advantageously on another. In the latter case, increased heat may be expected to produce effects that show an increase of vitality, whilst in the former, cold will produce the same result. A great excess of either heat or cold would, of course, be injurious to any species. To an insect that exists in Britain, at a mean temperature, say of 54°, but prefers 60°, any decrease of temperature will be injurious, whilst increased temperature will affect it beneficially, until it reaches 60°, and probably will not affect it prejudicially until it exceeds 66°.

It is a fact that the largest, most vigorous, and most brightly coloured specimens of *Chrysophanus phlaeas* are obtained in the temperate parts of the Palæarctic area, and that, as we pass south, the insect becomes less brilliant, darker, and often smaller. This tends to show that it is one of those species that prefer an environment more like that of our temperate climes, and that a higher temperature affects it more or less prejudicially. The most easily-marked evidence of this prejudicial action appears to be seen in the scaling, for, even in Britain, a very hot summer, like that of 1893, always produces a fair proportion of dark specimens, even in those localities where, in cooler seasons, the colour is most brilliant. This is sufficient to prove that the range of variation in the determinants of the scales is such as may enable the insect to be either black or of a bright ruddy golden colour, and the external stimulus which brings one or other of these extreme conditions to the fore, appears to be that of temperature.

If we apply the simplest elementary laws of vital force to our consideration of the development of the pupa, we find that the following facts hold good:—(1) The pupa, when first formed, has a certain amount of inherent vital force, by means of which, both the process of histolysis, and that of histogenesis, are carried on in it. (2) That pupa which has the nearest approach to the normal amount of vital force will undergo the most perfect histolysis and histogenesis, and will produce an imago most nearly conforming to the natural type, that is, to the form produced under the most healthy and satisfactory conditions. Conversely, the pupa whose amount of vital force is removed from the normal (whether by excess or defect) is the one in which histolysis and histogenesis will be least perfect, and the imago produced therefrom will be farthest removed from the normal type. (3) That individual which has been best fed, and which has enjoyed the most perfect health in the larval stage, will enter pupal life under the most satisfactory conditions, and will (the pupal conditions being equally satisfactory) emerge therefrom as the best specialised product, while the converse of this must also be true.

Another important point appears also to depend on an elementary principle. The vital force of the pupa is converted into energy; the energy at the disposal of the pupa is most probably directed, first, to the building up of the vital and reproductive organs, afterwards to the secondary organs or tissues, or such as are not necessary to life. Therefore, any excess of energy in a pupa will be expended, as a rule, on secondary structures rather than on vital ones, and so we find that a weak or diseased pupa fails first in regard to non-vital tissues, such as pigment, scales, wing membrane, etc.

It would appear therefore that, as a general rule, pigment, scales, etc., are well- or ill-developed in proportion to the amount of material and energy available for the purpose. As a result, such insects as pass through their metamorphoses at the normal temperature, produce the form which is normal for the district; that is, they undergo the normal processes of histolysis and histogenesis, and, in a state of health, have at their disposal the energy requisite to give them the normal wing-expanse, scaling and colour. If an increase or decrease of temperature lowers the vitality of the pupa, it lessens the available energy. The insect, therefore, does not develop under such favourable conditions; it needs what energy it possesses to build up its vital organs, and so fails in perfectly building up the secondary tissues. This failure is in direct proportion to the degree in which the vitality is lessened. If the temperature during the period of active development be below a certain degree, the vital force ceases to act at all, and death results. Heat, greater than that to which the insect is normally subjected, instead of reducing the vitality to the lowest ebb at which life can be sustained, affects the histolysis and histogenesis, usually, in a directly opposite manner. Under its influence the vital processes are carried on at express speed. Energy is expended at the fastest rate possible, and the tissues are developed without having sufficient time to mature, as they would under normal conditions (we may here suppose these to be those that are most beneficial to the species); the surplus material is rapidly utilised, with the result that as marked an abnormality is produced under the one condition as under the other, although in an opposite direction. It is conceivable that to insects which normally mature at a low temperature, a moderately high temperature might be fatal, and that the pupal tissues would not form at all. It is clear, however, that all changes in the environment of the pupa must necessarily produce some effect on its development. If the change be sufficiently extreme, then the effect is death; anything short of such an extreme will produce an effect proportioned to its magnitude. If a pupa be thoroughly acclimatised to a given range of temperature, then excessive heat or cold must be injurious.

The fact that an increased temperature produces dark specimens of *Chrysophanus phlaeas*, must be looked upon as simply a fortuitous circumstance, inasmuch as it appears to be largely due to the dark ground coloration of the scales, for, as we have seen, *Eugonia polychloros* becomes darker by the subjection of its pupa to a low temperature. Probably the physiological result is much the same in both cases; heat in the case of *C. phlaeas*, cold in the case of *E. polychloros*, being detrimental to the development of the most highly specialised individuals of these species.

We consider, therefore, that within the limits of existence, the possibilities of the germ are such, that the determinants of the scales (under the influence of intra-selection), present a range of variation within the extreme limits possible to the species, and that external influences determine, through their action on the organism, which of the three before-mentioned factors shall come to the fore in the final production of the scales.

There can be no doubt that it is in this direction that experiment and observation are particularly wanted, if we are to obtain any real, as apart from a theoretical, knowledge of the factors underlying variation. These problems relate rather to vital activities, and to physiological phenomena, than to anatomical structures, or the external guiding influence exerted by natural selection, and it is on these lines, it appears, that the laws governing variation will finally have to be worked out.

CHAPTER VIII.

THE PROTECTIVE COLORATION AND DEFENSIVE STRUCTURES OF LEPIDOPTEROUS LARVÆ.

We have already, incidentally, referred to the fact that the exposed life led by many lepidopterous larvæ, renders them very liable to be attacked by ichneumons, and to be preyed upon by various mammals, birds, reptiles, and carnivorous insects. We have also shown that they have undergone considerable modification, both for the purposes of concealment and defence. For the former, we have seen (*ante*, p. 43) that larval colours are often modified, probably by phytoscopic influences, and that natural selection has produced specialised patterns, by means of which the larvæ are suitably coloured to escape detection in the environment in which they are placed. For the purpose of protection, we have noticed how the simple hairs of the generalised setæ (*ante*, p. 45), and the fine clothing of the skin (*ante*, p. 38), may be respectively modified into dense hairy fascicles and a thick clothing of hair, which render the larvæ quite inedible to many entomophagous animals. We know, also, that the tubercles themselves may be modified into chitinous, prickly spines (as in the Vanessid, Saturniid, and many otherwise widely different, larvæ), which serve as a defence for the caterpillars against many of their enemies.

It may be here remarked that, since the larva leads an independent and entirely different mode of existence from that of the pupa and imago, it often happens that for the successful continuation of a species, a high degree of specialisation is necessary in the larval stage, and that the necessary modification has taken place without a corresponding specialisation of the other stages—egg, pupa, or imago. Conversely, it is conceivable that a highly specialised condition may be necessary in either of these stages, whilst the larva remains in a more generalised condition. It is, however, our intention to exclude the consideration of these latter contingencies at present, and to confine ourselves to those specialisations, defensive and offensive, which larvæ have developed for the purpose of protection.

We may premise, then, by stating that larvæ are protected in a variety of ways. They have, in many cases, adopted various habits of concealment when not feeding. Hesperid and Tortricid larvæ twist up leaves, Crambid larvæ make silken galleries; many gregarious larvæ (such as those of *Eriogaster*, *Malacosoma*, *Cnethocampa*, etc.) spin silken webs, and these live therein—whilst others (as *Drepana*, *Pyrameis*, etc.) spin leaves together, and dwell in the tent thus formed; others, again, feed only by night, some drop to the ground, and others throw themselves about violently, when disturbed. We have already noticed (*ante*, pp. 43-44) by what processes they have become specialised in colour, so as to resemble the leaves among which they rest. One of the most general forms of ornamentation of grass-feeding larvæ, is a series of longitudinal lines. These produce an effect resembling the lines of light and shade resulting from the illumination of a grass leaf, and due to the parallel venation of the leaf. Similarly, other larvæ are specialised in colour to resemble the twigs and other objects upon which they normally rest. We have already seen (*ante*, p. 42) that the specialisation of hairs and spines makes them unsuitable for the food of insectivorous birds. Other lines of specialisation by means of which they are protected are by eversible glands (sometimes taking the form of flagella), acid excretions, obnoxious odours, dangerous-looking spines, and horns, and spots; even remarkable attitudes help to swell the sum total of the defensive possibilities of larvæ.

That larvæ are protected by having a habitation into which to retire, and that they thus gain an advantage in the struggle for existence, appears certain. Nicéville mentions (*Butterflies of Sumatra*, p. 394) that the larva of a large Skipper butterfly (*Hidari irara*) and that of a Nymphalid butterfly (*Amathusia phidippus*) live, at the same time, on the leaves of *Cocos nucifera*. He says that, owing to their general abundance, the two species often have a severe struggle to live together, in which the more robust Hesperid, which secures a shelter for itself by spinning the leaves together, is generally victorious.

The various means by which larvæ are protected, owing to their similarity to some part of their food-plant, or by their resemblance to some object common upon it, is well-known. Some larvæ resemble structures on the leaves; thus, whilst the larva of *Apoda avellana* assimilates to the surface of an oak leaf, that of *Heterogenea cruciata* has been compared with a gall. Packard also says that the larva of *Lithacodes fasciola* and those of *Packardia* are entirely green, oval in form, and might easily be mistaken for a fold or bend in a leaf. The greater part of the Geometrid larvæ resemble twigs, whilst arboreal Noctuid larvæ are either coloured so as to suit their environment, or otherwise resemble some portion of the tree sufficiently well to escape detection, whilst ground-feeding larvæ resemble, in tint, the ground on or under which they rest by day.

Elliott says that the larvæ of the American *Heterogenea flexuosa* and *H. testacea* are wonderfully similar to the red dipterous or aphidid galls on oak and other leaves. Packard, too, notes the resemblance between these larvæ and the small reddish-green galls, which appear late in summer on the leaves at the time when the larvæ themselves become fully grown. He then adds: These forms being thus protected from observation and harm, do not need the armature of the larvæ of the other group (of this superfamily), and the tubercles and spines have disappeared through simple disuse; while being without poison-bearing spines, they have also lost by disuse the bright colours and conspicuous spots of the armed genera. On the other hand, the larvæ of *Odoneta*, *Empretia*, *Euclea*, and allied forms, with their remarkably bright colours and markings, and poison-bearing (? urticating) tubercles, feed conspicuously, the warning colours and showy ornamentation repelling the attacks of birds. We are inclined to the belief that the armed slug-worms were the earlier, from the probability that, in the Coleoptera, the earliest and most generalised groups were the *Staphylinidae* and the carnivorous *Carabidae*, and their allies; while the later, most extremely modified forms were the weevils and *Scolytidae*, in which the larvæ are footless. In the Diptera, also, it is not improbable that those families with the most perfectly developed larvæ, such as the *Culicidae* and *Tipulidae*, were the earliest and most generalised types, while the

Muscidae, with their apodous maggots, present the extreme of modification though not of specialisation, and so with other apodous insects and apodous Arthropods in general (*Proc. Amer. Phil. Soc.*, xxxi., pp. 84-85).

The resemblance of many lepidopterous larvæ to a bird's dropping is well known, and the same form of resemblance is often adopted by many lepidopterous imagines (*Antithesia salicana*, *Cilix glaucata*, etc.). So marked is this resemblance when the larva of *Jocheaera alni* is in its fourth skin, that it is commonly known as the "bird's dropping" stage. The young larva of *Papilio machaon* is similarly protected, and Nicéville says that "the young larvæ of *P. polytes*, like those of *P. memnon*, *P. helenus* and *P. nephelus*, have a strong superficial resemblance to a bird's dropping, which doubtless greatly protects them."

When we see a Geometrid larva stiff and rigid on a twig, we are at once attracted by the peculiar structure which enables it to maintain its shape, simply by the pressure of the body-walls on the contained fluids. We also observe how liable such a structure is to danger, and thus, while we note how suited the lepidopterous larva is to exert a great motive force at any movable point of its body-surface by means of its fluid contents, we recognise also that its liability to injury must necessitate some very successful expedients for its protection, if it is to fight its way through the hosts of enemies which surround it. When we examine a number of larvæ, we find how rarely they are provided with offensive structures, and, as a rule, lepidopterous larvæ rely on a purely passive defence, the most common of which is their resemblance to some part of their food-plant, such resemblance being their sole protection, and ensuring their escape.

We will now examine a few of the special cases in which larvæ resemble their food-plant so closely that they can only with difficulty be detected when at rest, and, for this purpose, almost any Geometrid, and numberless other, larvæ offer excellent illustrations. The young larvæ of *Iodis vernaria* hatches in July or August, is green in colour, rests on the stems of the food-plant (*Clematis*), stretching straight up, holding on merely by the hind claspers. It has a bifurcate hump on the pro-thorax, standing forward over the head, and its resemblance to a broken leaf-stalk, or tendril, is most remarkable. It is a hybernating larva, and in the late autumn, when the leaves and stems of the *Clematis* turn brown, the larva moults, turns brown with them, and exactly assimilates in colour with the stems of the plant. This brown hue it retains until the spring, and then, when it commences to feed, the brown skin is discarded with the first moult, and it becomes green again like the growing plant, retaining the green colour until pupation takes place. (The pupa, in a cocoon among the leaves, is also green, and the moth is green). If disturbed, the larva drops by a thread, remaining quite rigid, and looks just like a tiny piece of stick.

Somewhat similar to the changes occurring in the larva of *I. vernaria* are those of *Geometra papilionaria*. In this species, the young larva, which rests chiefly on the branches of alder and birch, is of a pale-brown colour, with, according to Poulton, some power of colour adjustment to the twigs of its food-plant. The larvæ remain brown during the winter, but, in spring, moulting produces dimorphism in them, some individuals becoming green, whilst others retain their brown hue. The larva also becomes stout, and comparatively short, and its resemblance at this stage to the catkins of the birch is very striking, the green larvæ resembling the younger, the brown larvæ the older, catkins. Harwood says that the brown larvæ mature later, and that the larvæ found on hazel are somewhat different in appearance from those found on birch.

Equally peculiar as to the change of colour, only in this case the change accompanies a change of habit, is that of the larva of *Emmelesia unifasciata*, which feeds within the seed-pods of *Bartsia odontites* when young and the pods are green, and is itself, at that stage, of a green tint, corresponding with that of the seed-pods. It, however, changes its habit by feeding outside, when almost mature, and contemporaneously with its last change of skin, it changes its tint and ornamentation.

Miss Gould says that the resemblance of the larva of *Rumia luteolata*, in shape as well as in colour, is extremely protective, the angular attitude of the larva at rest, rendering it almost indistinguishable from the twig. In the case of larvæ with green surroundings, this likeness is greatly heightened by the touches of red, which exactly match the thorns and one side of the stem of the young hawthorn shoot. Poulton also, referring to this species, says that the resemblance of the larva to a twig of its food-plant is most striking, for the dorsal tubercles which are to be found near the middle of the larva represent very faithfully a superficially similar structure upon many side twigs of the food-plant, and, he further notices, that not only do these projections occur towards the middle of the length of the twigs, but they are situated on the angle of a slight bend, a character which is also produced in the larval form. He further points out that the different forms of the larvæ are coloured in almost the same manner as the varying tints of the hawthorn twigs. He considers that the remarkable specialisation of the form and colours of certain larvæ to a special food-plant, gives a strong clue to the ancestral food-plant of a species, whose larva now feeds on more than one plant.

Barrett notes the resemblance that the larva of *Eupithecia extensaria* bears to its food-plant, *Artemisia maritima*, and says: The stems and leaf-stalks of the plant are furrowed and clothed with white down, in such a manner that all appear striped, with alternate green and dull white, and this larva is similarly ornamented with longitudinal stripes of the same colours and of the same width; the young flower-buds of the plant are tipped with brown, and the front of the head of the larva is coloured in the same manner; the segments of the leaves are somewhat tumid at the tips, and the anal legs or claspers of the larva are swollen or rounded into precisely the same shape. This last adaptation would appear superfluous, if it were not for a curious trick which the larva has, at times, of raising its posterior end stiffly out while holding on by its thoracic legs—thus apparently standing on its head.

The special resemblance that the full-grown larva of *Hybocampa milhauseri* bears to a curled oak-leaf, partly eaten and abandoned by a *Tortrix* (*viridana ?*) larva has been well described (*Entom.*, xxiii., p. 92) by Chapman. He says: By chance I one day brought in with the food for some larvæ of this species, so exact a resemblance of the full-grown larva, that there could not be any doubt as to the meaning of all its curious outlines and markings. This was a curled oak-leaf, eaten and abandoned by a *Tortrix* (*viridana ?*) larva. This particular leaf was, in detail, exactly imitated by the larva of *H. milhauseri.* There was a curled portion of leaf with the outline of the body of the larva, the netted green texture of the leaf like the small markings on the surface of the larva, whilst a brown decayed mark or two were similar to those found on it; the extremity was eaten off on lines partly following a rib, so as to imitate the truncate aspect the larva has, however viewed; whilst the secondary ribs of the leaf, being eaten between, projected laterally from the roll, just like the dorsal spines of the larva, and in about the same size and order; the tall one on the 5th segment, the dwindling ones on the 6th-10th, and the taller bifid one on the 12th, this one resembling points from both edges of the leaf. Most curious, perhaps, of all, the little backward projecting points at the tips of the spines (or humps), apparently so superfluously complicated in the larva, were exactly represented in the leaf; the *Tortrix* larva, in eating the substance of the leaf between the secondary ribs, had eaten these down to some extent also, but stuck fast just at a tertiary branch, the small remaining portion of which precisely represented the backward process of the larval spine. I never met with another rolled leaf that happened, in exact number, size and position, to represent all the processes of the larva as this one did, but almost any rolled and abandoned leaf bore a very close resemblance to the larva.

The resemblance of the larva of *Smerinthus ocellatus* to a willow or curled apple leaf, is most remarkable, and the larvæ of both our other British Smerinthid species similarly resemble the curled leaves of their respective food-plants. The lateral stripes give an idea of light and shadow on the supposed leaf, and the similarity to a willow leaf is often increased in the case of certain larvæ of *S. ocellatus*, in which extra red lateral spots resemble very closely the little red galls on the willow leaves. In America, it has been found that the red blotches on the larvæ of *S. myops* are not at all uniform in number, and are much more frequently found on examples of the late brood, although some of them are entirely green. These red spots correspond exactly in colour with similar spots found on the leaves of the wild cherry (the food-plant of the species) at that seasen. Poulton has given (*Trans. Ent. Soc. Lond.*, 1887) a detailed account of the remarkable manner in which the larva of *Deilephila hippophaes* is specialised in regard to its colour and markings, so as to resemble even in minute detail the peculiarities of its food-plant, *Hippophaes rhamnoides*, and he states that not only are the colours of the leaves faithfully carried out, but the characteristic orange berries are represented by an orange spot at the base of the caudal horn upon each side.

Holland notes that he picked up a full-fed larva of *Stauropus fagi* on the path of a beech wood, which very closely resembled a curled-up beech leaf, like those beside it on the path. Poulton says, that when at rest and undisturbed, the larva is difficult to detect, and is protected by its resemblance to a withered beech leaf irregularly curled up, the body, which is often held asymmetrically, representing the leaf, being of about the appropriate diameter, colour and length, whilst the two caudal processes, modified from the last pair of prolegs and always applied together when at rest, represent the leaf-stalk. The second and third pairs of thoracic legs, folded in the middle of their length, hang down, and resemble a bunch of the stipules of the foliage leaves of the beech.

Among American larvæ we find many illustrations of this nature. Packard says that the larvæ of the *Schizurae* exactly imitate a portion of the fresh, green, serrated edge of a leaf, including a sere-brown withered spot, the angular serrate outline of the back corresponding with the serrate outline of the edge of the leaf; and, as the leaves only become spotted with sere-brown markings by the end of the summer, so the single-brooded caterpillars do not, in the northern States, develop so as to exhibit their protective coloration until late in the summer, *i.e.*, by the middle and end of August. The larva of *Schizura leptinoides* is of the same shape and colour as a sere-brown, more or less twisted portion, of a serrated leaf, such as that of beech, hornbeam, and similar trees. The larva of *S. unicornis* is pale, with much glaucous colour about the back, and with certain shades of purple-brown, flesh-brown, olive, and pale green, that make it very similar to the tints found on the withering leaves and canes of the blackberry bushes. Miss Payne writes (*Amer. Entom.*, ii., p. 341): I think this caterpillar furnishes a wonderful instance of mimicry. The green segments just behind the head resemble a small portion of the green leaf, and the other parts admirably counterfeit the brown and russet tints of the dead leaf, whilst the form of the animal in its various postures aids the deception, by its resemblance to a leaf partly living and partly dead, the green mostly eaten, and the brown torn. Riley writes: The mimicry of the larva, when on the blackberry, either stem or leaf, is perfect, and the imitative resemblance of the moth when at rest, to the bark of a tree, is still more striking.

Hudson records (*Entom.*, xxiii., p. 55) that while gathering some small branches from a birch-tree, on the table-land of Mount Arthur (New Zealand), he discovered a beautifully variegated larva imitating exactly the delicate hues of the lichen-covered twigs. After feeding for a few days, it pupated, and, on June 7th, the imago emerged as a very grey form of *Declana roccoae*. He states that he had often before seen the larva of this species around Wellington, where, however, it does not in the least resemble the curious caterpillar found on the table-land. A very similar instance is to be found in the larva of our British species, *Cleora lichenaria*. So variable is this larva, that it exhibits some peculiarity in almost every locality in which it occurs, the peculiar tint, etc., causing it to closely resemble the particular lichens on which it is feeding. Many years ago, Möller noticed a general tendency for the larva of *Amphidasys betularia* to be yellowish-green when living on the birch, ashy-grey when on oak, yellowish-brown when on elm, yellowish-green, clouded with rust colour, when on willow or poplar. This general tendency in nature has been found by Poulton to be paralleled in confinement, under varying conditions of environment, and the great amount of colour-variation artificially obtained by this experimenter, shows how valuable all such colours may be under certain possible natural surroundings, or on certain plants that the species is known to affect. Thus, Poulton correlates the whitish larvæ of this species with trees and shrubs having white pubescent or glaucous shoots. The green larvæ he connects with rose, the green shoots of sallow, broom, and *Ribes americana*. The brown forms are associated with cherry, oak and birch, whilst Sidgwick has noticed a difference between the dark larvæ beaten from oak and birch corresponding with the difference between the twigs on which the larvæ rest in the two cases. Wilson beat a larva of this species from a lichen-covered food-plant, that so exactly resembled the lichen, that he thought the larva must be that of another species, until the moth appeared.

The longitudinal lines of the larva of *Panolis piniperda* make it almost invisible when hiding among the needles of the Scotch fir. The larva of *Anarta myrtilli*, with its intricate crossing and recrossing of lines, is scarcely discernible when resting on a heather twig. The larva of *Anticlea cucullata* (*sinuata*) is scarcely to be detected on the seed-heads of *Galium verum*, nor that of *Cidaria sagittata* on those of *Thalictrum flavum*, so close is their resemblance to their respective food-plants, when at rest. Even the large hairy larva of *Eutricha quercifolia*, when motionless on its food-plants—sallow, hawthorn, blackthorn and buckthorn—is so difficult to detect, that the usual way of finding it, on Wicken Fen, where the species is abundant, is to run the hand down the stems to feel for it.

Besides instances, such as those just quoted, of special protective resemblance between a larva and its own particular food-plant, a general protective resemblance, due to a general harmony between the object and its surroundings, is often to be observed. It seems almost impossible to understand how there can be a general harmony between some large and apparently conspicuous larvæ and their food-plants, when one considers them apart from each other, but when one sees for the first time, the larva of *Deilephila euphorbiae* or *Papilio machaon* on its food-plant in a state of nature and surrounded by those plants that make up its natural environment, one is no longer struck with the difficulty often experienced in a first search for the larva, and recognises that, in the blending of the various tints of the plants around it, the fitness of the colours of the caterpillar, for its effectual concealment, is very evident. In such cases as these, the larva does not resemble any one particular piece of the food-plant, but the general character of the larva mimics or resembles the general environment, whilst special parts of the larva represent special objects in the environment.

One of the best examples of this general protective mimicry is afforded by the larva of *Charaxes jasius*. This larva rests on the upper surface of a leaf of *Arbutus unedo* (or on a bunch of leaves fastened together with silk), basking in the sun by day, and always fully exposed. One might suppose from this, that the larva would be very conspicuous, yet, on the contrary, it is difficult to detect. Chapman says (*Ent. Record*, ix., p. 193): The larva at rest, seen from whatever direction, exactly imitates some aspect of leaves or buds under the different effects of light and shade, and it is thus possible for an untrained eye, in many instances, to look at it, and for it, for some time before seeing it. The yellow lateral line resembles the mid-rib of the leaf seen from above or below, according to light; the colour and apparent texture of the skin are the same as those of many leaves. The extraordinary head, with its coloured jaws and spines, suggests in many aspects, the little group of buds at the extremity of the branches. One has often to look a second time at certain leaves and branches, as well as at the buds, to be sure that they are parts of the tree, and not a larva. The curiously coloured circles on the back of the abdominal segments 3 and 5, which are more brilliant with their blue and yellow than anything on an *Arbutus* leaf, nevertheless produce exactly the effect of certain little rings of fungus or decay, that are very common on the leaves.

In the mimicry of larvæ, then, it is to be noticed that many of them do not so often exactly imitate the thing mimicked, as some particular aspect of it under certain illuminations, and so, in *C. jasius*, the larva is not at all like a leaf, but many leaves on a tree will look exactly like some particular larva does as it rests amongst them. In the same way, the head does not resemble the buds at all closely, yet, Chapman says, he has fancied he saw a larval head, when, after all, it was only a group of buds.

Perhaps the most typical instance of this indirect mimicry is exhibited by the larva of *Acronicta leporina*, which, seated beneath an alder leaf, looks exactly as if a spot of sunshine were falling upon the upper side of the leaf. This larva, considered away from its food-plant, is very conspicuous. It is dimorphic in its coloration, one form of the larva being green with white hairs (attached more particularly to alder), the second yellow, with distinct chocolate dorsal and lateral bands, olive-brown beneath, with yellow hairs (attached more particularly to birch). Chapman has observed that the white-haired form sits somewhat curled round, near the middle of the underside of an alder leaf. Looking down from above it is absolutely hidden, looking up from beneath it ought to be very evident, but this is far from being the case. Chapman says that he has several times missed a larva till he has looked three or four times, and has also fancied he saw a larva where none has been. In looking up from below through the foliage of an alder tree, most of the lower leaves are in the shade of the upper ones, but here and there a gleam of light falls through upon a portion of a leaf, and gives it quite a different tone and appearance as seen from beneath. A larva of *A. leporina*, seated beneath an unilluminated leaf, precisely resembles one of these patches. Poulton considers that the yellow larva on birch is protected by its resemblance to a cocoon, but Chapman points out that cocoons are not very common objects on birch leaves, although, as he shows, the deserted domiciles of larvæ, such as *Asphalia flavicornis*, etc., are so, and the resemblance of the larva to these is heightened by the black tufts that often persist in the yellow form, and which resemble bits of frass and dark chips that are frequently entangled in such vacated lodgings. At any rate, *A. leporina* presents a marked instance of a dimorphic larva, each form being suited to different circumstances, and almost certainly for purposes of concealment. Freer has pointed out that on Cannock Chase, where both forms occur, the green one being confined to alder, the yellow form is the later one, and, occurring principally on birch, is of the same tint as the dying birch leaves.

Dyar, commenting on the mimicry exhibited by the larvæ of the American Acronyctids, says (*Trans. New York Acad. Sci.*, xiv., p. 58): The larvæ of the genus *Acronycta* (in its wider sense) are wonderfully varied in appearance, and I believe that this diversity is due to mimicry of all sorts of objects, from that of resemblance to the foliage (*grisea*, *tritona*, etc.) to warning colours (*oblinata*), and mimicry of special objects, such as a spider's nest (*vulpina*), or of some other specially-defended larva, *e.g.*, *A. radcliffei* which mimics *Datana*, and *A. luteicoma* which probably mimics *Notoloplus* (*Orgyia*).

Probably the majority of lepidopterous larvæ are more or less protected by their general resemblance to their environment, even when the protection is enhanced by the more or less exact resemblance of a particular species to some special object.

In the preceding paragraphs we have once or twice incidentally referred to the fact that a peculiarity of larval shape, of movement, or of resting position, may constitute an efficient aid to the protection afforded by some particular shade or shades of colour. Poulton (*Trans. Ent. Soc. Lond.*, 1885) discusses the protective value of the peculiar attitudes assumed by the larva of *Selenia bilunaria* (*illunaria*), and the peculiar rhythmical lateral movements which are observable in this and other Geometrid larvæ. Even the readiness of certain larvæ to drop to the ground when disturbed, and to remain there for a considerable time motionless and rigid, is highly protective, and amongst loose pieces of stick, pine-needles, or tall grass, a successful search is almost out of the question. Poulton further observes (*Ibid.*, 1887, p. 291) that the young brown larvæ of *Selenia lunaria* twist themselves into an irregular spiral when seated on the leaves of their food-plant, and that this attitude is sometimes assumed by the mature larva when resting in such a position. Somewhat similar habits have been noticed in the larvæ of *Zonosoma pendularia*, *Z. annulata* (*omicronaria*), *Z. orbicularia*, *Aspilates ochrearia*, and *A. gilvaria*. The young larvæ of *Rumia luteolata* have the same habit, generally sitting on the edge of a leaf, close to the place from which a piece has been eaten. In this position, the larva suggests most strongly the appearance of a small part of the leaf which has been injured, and then curled up and turned brown, but still remains adherent by one end to the uninjured part of the leaf. Miss Gould has noticed that the brown larvæ of this species have a habit of hanging by a thread, twisting round rapidly whenever disturbed, and mentions their similarity to bits of dead stick or pieces of leaf that one frequently sees spinning in this manner.

In most cases in which larvæ resemble twigs when at rest, the larva spins a slight silken pad or a few strands of silk on the branch at that point where it takes up a resting position. This, of course, gives it a better hold, and, in the case of Geometrid larvæ, allows them, after having obtained a firm grip by means of their prolegs, to extend the body rigidly from the twig. The larva of *A. betularia* and other species often, however, extend themselves obliquely between two twigs, holding one by its prolegs, the other by its true legs. Such a larva presents the appearance of a twig passing obliquely between two others. Sometimes larvæ of this description are supported by holding with their thoracic legs, a leaf upon, or an advanced part of, the same stem as that to which they are clinging by their prolegs. In this manner they are still more effectually concealed.

The resemblance of such larvæ as are effectively protected when resting on twigs, to the twigs upon which they rest, is sometimes greatly increased by the development of small, fleshy tubercles, or lateral hairs, along those edges of the body which are in contact with the twig, and which help to break the otherwise sharp distinction between the larval form and the twig. Meldola has pointed out developments of this description in the larvæ of *Eutricha quercifolia* and *Poecilocampa populi*, which enable them to rest more securely on branches and twigs without throwing a sharp shadow. Poulton shows that in Geometrid larvæ such protection as is afforded by growths of this kind, necessitates their development only at those parts between the two posterior pairs of prolegs, where the larva is in contact with the twig, because, the bark of a twig and its branch being continuous, anything that suggested a deep furrow between them would destroy the protective resemblance. On these parts of the Geometrid larvæ, therefore, we find such minute fleshy outgrowths frequently developed. In the larva of *R. luteolata*, the fleshy processes exactly correspond with that part of the body which would otherwise come as a dark shadow in the deep cleft between itself and the branch. The processes appear to soften the contact between the larva and its food-plant, not only by partially filling up the cleft, but also by neutralising the shadow in the groove which remains. These lateral growths are very noticeable in the larvæ of Catocalids, Lasiocampids, etc., and are also well developed in the larvæ of *Metrocampa margaritaria* and *Aventia flexula*.

It is difficult to deal with the broad question of the influence that food has on the colours of larvæ, but some short account appears to become absolutely necessary at this stage of our enquiry. In the first place, it appears advisable to point out that, in the larval stage of insects, it is of the utmost importance that the storage of reserve material on which the organism can draw, to enable it to undergo its later transformations, should be effectually carried out. We find in lepidopterous larvæ that this need completely overwhelms the necessity of perfect assimilation, and, hence, material assimilated in a more or less unaltered condition, may frequently carry with it the cruder constituents of which the food is made up. In this way only is it possible to imagine a slightly modified form of chlorophyll becoming transferred to the animal tissues, and hence affecting directly the colour of the larva.

McLachlan noticed, in 1874, that flower-feeding larvæ often assume (in the same species) the colour of their food. Meldola considered that this might be due to the colouring matter of the food being assimilated in an unaltered state (*E. M. M.*, xi., p. 162). Later, Meldola pointed out that it was probable that the food-plants directly influenced the variation found in the ground-colour of the larva of *Smerinthus ocellatus*, and Poulton described at length experiments made upon this species, by feeding the larvæ *ab ovo* on various food-plants. In these experiments, apple (cultivated and crab) gave whitish-green larvæ; *Salix cinerea* and *S. rubra*, larvæ inclining to the yellowish form; *S. viminalis*, intermediate forms. In the field, although this general tendency is observable, there are many striking exceptions, and the latter, probably, may be explained by supposing that they are due to hereditary influences, and that such larvæ are not, therefore, able to take full advantage of their food as a means of protection. Poulton further notices the darker coloration of larvæ of *Sphinx ligustri*, when fed on ash or lilac, compared with that of those fed on privet. The former are greyish-green and the purple stripes duller. In 1885, Poulton gave (*Proc. Roy. Soc. Lond.*, p. 269) a number of details relative to the way in which altered plant pigments are utilised in larval coloration. He considered that the green ground colour of many lepidopterous larvæ was due to green pigments dissolved in the blood, whilst, in the case of certain Sphingid larvæ, he believed that the pigments passed from the blood into the hypodermic cells, and so coloured the larvæ, whilst later experiments (*Trans. Ent. Soc. Lond.*, 1886, p. 169) led him to suppose that the colour of the larva of *S. ocellatus* was essentially due to the segregation of the pigment in these cells, the blood itself being comparatively free from the pigmentary matter. He further states that before pupation the pigments are withdrawn from the cells, and are dissolved in the pupal blood. Poulton concludes that the larva of *S. ocellatus* maintains a colour-relation with the food-plant on which it is hatched, adjustable within the limits of a single life, and that the predominant colour of the food-plant itself is the stimulus which calls up a corresponding larval colour, and, further, that natural selection has finally produced a resemblance—either general or special—to something which is common to all the food-plants of the larva, or to some one or more of them, the larva being less protected upon the remainder; but, in this case, the same gradual process has finally given the larva a power which (relatively) immediate in its action, enables the organism itself to answer with corresponding colours the differences which obtain between its various food-plants (*Proc. Roy. Soc. Lond.*, 1886, p. 172).

A larva of *Cossus ligniperda*, exhibited at a meeting of the Ent. Soc. of London, some years ago, had lost its ordinary colour, and had become pink, and then white, from having been deprived of its natural food, and confined for eighteen months to a diet of pink paper, with which the cardboard box in which it was kept was lined, and, subsequently, to the cardboard itself. It was suggested that food assimilated in a more or less unaltered condition, had probably influenced the colour of this particular larva. At the same time, the later (white) coloration may have been due to an etiolated appearance caused by starvation. It appears certain that in nature this mode of assimilation of food must be considered as the basis of any direct influence that may be exerted by the coloration of the food on the coloration of the larva, and this is borne out by the yellow coloration of larvæ of certain *Eupithecia* species (*absynthiata*, etc.), found feeding upon ragwort flowers, and similar instances. As a rule, however, the colouring matter of flowers and leaves cannot be so directly used, and only some modification of the colouring matter at the most, can, in very many instances, be elaborated into the colouring matter of the larva, for the physiological processes demand the digestion, as well as the assimilation, of all material that enters the larval blood, and one would surmise that it is only after entering the blood that it can be elaborated into new colouring pigments by the larva. That it is usually not a mere matter of the transference of plant pigment to the larva is certain. It is probable that in such dimorphic larvæ as those presented by species like *Hadena oleracea*, *Mamestra persicariae*, *Geometra papilionaria*, and others, in which two forms appear on the same plant under identical conditions, the difference is essentially a difference of epidermal structure, the green colouring pigment being in the subjacent fat cells (or rather in the blood bathing these cells), in each form of these species, but screened off, as it were, in the darker forms, by a modification of the integument itself. Such appear to be the more prominent facts and suggestions relating to phytophagic coloration.

Poulton, however, has more recently carried out elaborate experiments on various species, which tend to show that the response of larvæ to their environment is due, in some instances, to phytoscopic rather than to phytophagic causes, and that it is the colour of the surface of the leaf, rather than its substance, that acts as the stimulus in producing the different colours of larvæ under varying conditions of environment. As a case of extreme specialisation in larval coloration, we would instance *Abraxas grossulariata*. The typical form of larva of this species must be well-known, but examples may be obtained in London gardens, and probably elsewhere, in which the colour is almost, in others, absolutely, black, and yet there is no corresponding difference in the colour of the imagines, the difference in colour being purely adaptive to the needs of concealment in the larva. The larvæ of the Catocalids (and the allied genera, *Homoptera* and *Pheocampa*), the tree-feeding Notodonts and Geometrids, and many Lasiocampids, are spotted and mottled with various tints of brown, grey, and ash, so that their colours assimilate with the colours of the bark of the trees on which they rest. Such larvæ are also frequently provided with dorsal and lateral humps and warts, so that they also resemble the shape of the twigs (with their knots and leaf-buds), and thus make the resemblance more complete. We have already mentioned that the larvæ of *Amphidasys betularia* are very variable—whitish grey, different forms with varying shades of brown, to quite brown, whilst others take another direction, and are of a distinct green hue.

The experiments carried out by Poulton to demonstrate the response of larval colours to the environment are detailed at length (*Trans. Ent. Soc. Lond.*, 1892). His experiments, based on the subjection of the larvæ throughout their existence to varied conditions of environment, tend to show that whilst some larvæ are affected by the conditions of their environment, and effectively respond thereto, others are quite obdurate and remain constant, whatever the conditions of their environment may be. Poulton's conclusions work out as follows: (1) Regularly dimorphic forms, with intermediate varieties rare or wanting, are never, so far as our present knowledge extends, susceptible to surrounding colours, while variable species tend to be so. In this respect, *Geometra papilionaria* is very interesting, being susceptible when young, but not later, when it is dimorphic. (2) The larvæ of Noctuids are far less sensitive to change than those of the Geometrids. The most susceptible of the former, the Catocalids, are arboreal, and specialised for concealment among twigs and on bark. In the Catocalids there is sometimes a most extraordinary fluctuation in the amount of susceptibility within the limits of the same genus. (3) Only among the Geometrids were green larvæ produced by the experiments. Out of eleven species operated upon, all but one showed some sensitiveness to colour surroundings. (4) There is no evidence to show that the colour acquired by a larva can be transmitted to its progeny; the susceptibility is simply an adaptation to the differing environments in which the larvæ find themselves.

Concerning the time necessary for the colour change to appear, Poulton gives the following :—

1. Some effect was produced in 8 days in young larvæ of *Geometra papilionaria.*
2. Some effect was produced in 8 days in young larvæ of *Catocala electa.*
3. Much effect was produced in 12 days in young larvæ of *Crocallis elinguaria.*
4. Much effect was produced (about) 14 days in young larvæ of *Melanippe montanata.*
5. Much effect was produced in 11 days in young larvæ of *Catocala elocata.*
6. Much effect was produced in 13 (or less) in young larvæ of *Hemerophila abruptaria.*
7. Much effect was produced in 17 days in young larvæ of *Rumia luteolata.*
8. Much effect was produced in 8 days in young larvæ of *Amphidasys betularia.*

He then summarises the main facts relating to his observations as follows:—(1) When carefully watched for, the changes are sometimes seen to occur quite suddenly (*C. elinguaria* and *R. luteolata*). (2) The effects cannot be reversed by reversing the surroundings for a short time (*C. elinguaria, H. abruptaria, A. betularia*). (3) When the conditions are uniform the environment does not necessarily destroy individual variability, but the most powerful forms of environment, when applied to highly sensitive species, very nearly do away with it. If, however, the environment be mixed, there does not appear to be any instinctive knowledge leading the larvæ to rest only on appropriate objects. Thus, if they have become green, and are beyond the power of change, they will nevertheless rest on brown twigs in preference to green leaves. The habit of these Geometrids is to rest upon twigs under any circumstance, and this is probably the reason why a small proportion of twigs will produce a great effect. (4) Contact, or at least the closest proximity, is required to effect the change. (5) Although larvæ of *A. betularia* are so much more susceptible to brown surroundings when these are mixed with green, there were *no* exceptions among 105 larvæ which, in 1889, became green among leaves and shoots. In the case of larvæ of *R. luteolata* and *A. betularia*, there is direct evidence of the power being efficient in concealing the wild larvæ. (6) The larvæ are, probably, chiefly sensitive at the time when they quit the leaves, and first begin to rest on the twigs. (7) Darkness does not produce so great an effect as black surroundings in a strong light (*A. betularia, R. luteolata, C. elinguaria*). (8) Overcrowding tends to produce dark larvæ (*A. betularia, R. luteolata*). (9) As might be expected, the effects produced on the larvæ do not influence the colour of the moths.

There can be no doubt that these changes in the larval coloration are such as would effectively bring about the concealment of the larvæ. In the majority of the larvæ experimented upon, the only possible change appears to be from dark brown to light brown, or to greenish-brown. Larvæ of the latter colour are, however, much less conspicuous on leaves than the darker forms, although they are not nearly so well protected on the dark twigs. Poulton thinks that when the larvæ of any one of these species hatch upon a part of a tree where there is a great abundance of young green shoots, their susceptibility would certainly lead them in the direction of concealment. It by no means follows that the power is useless in certain species, because it leads to more perfect results in others. Concerning the latter, no one who has once seen the larvæ of *A. betularia* and *R. luteolata* upon their food-plants in the field, can have doubt about the meaning of the changes in colour which they undergo.

Eleven larvæ of *Rumia luteolata* placed in green surroundings, on July 7th, 1890, by Miss Gould, produced 1 brilliant green, 2 lighter green, 6 duller shades of green (whilst two disappeared). Eleven other larvæ from same batch, among dark-coloured surroundings, produced 3 dark brown, 3 brown, 2 greenish-brown, 2 green (one larva disappeared). Larvæ of *Catocala nupta* also responded very readily to differences of environment, the change consisting of the normal colour becoming lighter or darker, and the markings varying in intensity, although the difference between the most extreme forms from light and dark surroundings, respectively, was very great. *C. fraxini* also responded readily, 5 larvæ, in dark-coloured surroundings, becoming brownish-grey in colour, 5 others, in green surroundings, becoming bluish-green. Poulton extended the results obtained by Miss Gould in *Catocala*, by showing that *C. sponsa*, *C. electa* and *C. elocata* were also susceptible to colour influences in their environment. One cannot help remarking here that the number of larvæ experimented upon, although affirming the principle, is quite insufficient to base any sweeping generalisations upon. Poulton has further shown that larvæ of *Amphidasys betularia*, *Selenia lunaria*, *Rumia luteolata*, *Melanippe montanata*, *Crocallis elinguaria* and *Hemerophila abruptaria*, are highly sensitive, and that larvæ of *Ennomos quercinaria* (*angularia*), in addition, are greatly influenced by actual darkness. This latter result, Poulton states, is exceptional, for larvæ brought up in total darkness are usually lighter than those reared among an abundance of dark twigs in strong light.

The structural cause of the variation in the colours of *Amphidasys betularia* was investigated by Poulton. He found that the colour of the larva was in the skin, or just below it. In all the larvæ experimented upon, he found that the colour of the fat just below the skin was green, in some brown larvæ it was a bright green, as in the green ones. This green fat was found to contain green colouring matter (probably some derivation of chlorophyll) in the oil globules within the cells. When the epidermis is comparatively clear, the green colouring matter shows through, but when the epidermis contains a dark pigment, the skin is interposed like a screen outside the green fat, and the larva takes on the appearance or tint of the darkened epidermis. In green larvæ the epidermal layer, covering the green fat, contains a substance of a light yellow transparent colour, that appears greenish-yellow under the microscope, the cuticle itself being colourless, except for certain small brown spots. The darker larvæ obtain their colour from a dark pigment contained in the epidermal cells, which thus conceal the subjacent green fat, so that, if we accept Poulton's explanation, it would seem that the reflection of the light from the surrounding objects has to produce such nervous action as results in an actual physiological change in the deposition of pigmentary matter in the epidermis. Poulton suggests that some quality of the light brings about the change, but of the actual mechanism that produces this result, we know absolutely nothing.

Packard says that it is possible that the close resemblance of the warts, projections and spines of certain arboreal caterpillars, which so closely mimic the spines, leaf scars, and projections of the branches or twigs of plants, has been brought about in a way analogous with the production of spots and lines on the body of caterpillars. Darwinians, he says, attribute this to the action of "protective mimicry," but this expression rather states the result of a series of causes. The effect of dark and light shades, and the light and shade, in producing the stripes and bars of caterpillars, is comparatively direct and manifest; but how can thorns and other projections, on trees and shrubs, affect caterpillars directly? Given the origin by hypertrophy of warts and spines, it is then easy to see that by natural selection caterpillars may have finally become adapted so as to mimic similar vegetable growths. Our object is to endeavour to explain the causes of the primary growth and development of such projections, *i.e.*, to lay the foundation for the action of natural selection (*Bombycine Moths of America*, p. 20).

With regard to the origin of the humps, by means of which many tree-feeding Geometrid and Notodont larvæ resemble portions of their food-plants, Packard further says: The change was probably not necessarily due to the stimulus of the visits and attacks of parasitic insects . . . . The cause was probably more pervasive, and a result of a change of environment. He considers that they are mere adaptive characters, and may have originated with comparative suddenness, and, in certain families, *e.g.*, the Notodonts, were due to the change from feeding on low plants to an arboreal mode of life. That these had any sudden origin, we do not for a moment believe, and Packard's suggestion that there is a very sudden change in most larvæ from a generalised condition in their first and second skins, to a specialised one in the third, is only true so far as there is often a marked change at this stage, but usually the change is a much more gradual one, and only finally culminates in producing the maximum of dense fascicles and hairs towards the end of the caterpillar's existence.

One of the most remarkable modes of protection adopted by a lepidopterous larva is that of *Phorodesma smaragdaria*. This larva covers itself with pieces of its food, the particles being bitten off, apparently so that it may the more completely resemble its food-plant. These particles adhere to the skin of the larva by means of a sticky substance, which was generally supposed to come from the mouth, or spinneret, but which White states is excreted by certain glands developed irregularly upon various segments of the body. He says: "These glands are seen, by means of a good lens, to be prominent elongate processes, of an almost pure white colour, each bearing, at the top, a single, rather long, stiff hair, which doubtless serves to spike the fleshy substance of the *Artemisia*. . . . . . The gummy exudation is exceedingly tenacious. . . . . . The skin is much wrinkled in the subspiracular region, forming an irregular and somewhat flattened fringe upon the sides of the anterior segments, adding greatly to the general protective resemblance of the larva to its food-plant" (*Proc. Ent. Soc. Lond.*, 1888, pp. xx-xxi). The larva of the allied *P. pustulata* is well-known to have a similar habit.

Apart from the different forms of protective coloration, which larvæ assume, and which have been already considered, there are many larvæ provided with various conspicuous marks of bright and startling colours, which are supposed to have a terrifying effect on any enemy to whom they are suddenly exposed. Other larvæ, again, take up various positions which have been interpreted as being likely to inspire fear in their enemies. Then we find that certain larvæ are provided with tubercles which they can move, and the movement of these has also been considered as being of value to their possessor, in aiding in its protection. Others, again, are supposed to be highly coloured as a warning that they are inedible. We can only deal with one or two typical examples to illustrate each of these specialised characters.

Poulton describes certain terrifying marks as existing upon the 1st abdominal segment of *Aglia tau*, and placed above the white spiracular line. It consists of a white area, enclosing a dark reddish patch, usually slightly invaginated, and, therefore, hidden during rest behind the lobed upper margin of the sub-spiracular line. When the larva is irritated, increased contraction of the body walls produces greater pressure upon the fluid contents of the body, and unfolds the shallow pouch-like invagination behind the lobes, thus exposing a greater surface of the white area, and rendering the dark centre visible. Weismann has shown that the origin of the terrifying marks in the larvæ of *Choerocampa elpenor* and *C. porcellus* is very similar, the differences largely following from the arrangement by which the eye-like marks are concealed in the former species, except when they are actually needed. In the larva of *Stauropus fagi*, Müller discovered, on the 1st and 2nd abdominal segments, below, and rather behind, the spiracles, a shallow pouch-like involution of an intensely black colour, each black area being entirely concealed by a triangular flap, growing from the lower margin of the area, and directed upwards. When the larva is irritated, the flap is depressed, the pouch-like structure is partly everted, and the black patches become visible. Müller thinks that the patches are intended to imitate ichneumon stings; Poulton, that they may represent a clot of blood derived from a wound inflicted by a parasitic enemy. It is suggested by both observers that the exposure of these tends to show that the larva is already occupied by a parasite.

Among the American lepidopterous larvæ, the brightly hued caterpillar of *Symmerista albifrons* is provided with a showy, coral-red hump, and with bright black and red bands on a shining glistening skin, which Packard considers may be interpreted as danger signals to birds, to whom the caterpillar is distasteful. The same observer calls attention to the great dorsal spines, which run entirely along the body of the larva of *Schizura concinna*, as well as the large lateral spines, which bear some resemblance to elongated hobnails. These probably render the creature very distasteful and repulsive to birds, and less open to attack from parasitic insects. Packard says that we have in the larva of this species a system of conspicuous markings and noticeable appendages, which all result in giving warning to birds that it is inedible . . . . In the larvæ of other *Schizurae*, we have a mixture of two properties; they are, as we have shown, disguised to resemble a part of a brown-spotted green leaf, and they also bear a movable, deterrent spine on the back. In *Symmerista*, the larva is so gaily coloured as to at once indicate to birds that it is distasteful, but here are no deterrent spines or bristles. Edwards notices that he once observed the gregarious larvæ of *Symmerista albifrons* feeding on dwarf willow, where their brilliant colours gave to the plant, at a little distance, the appearance of a raceme of showy flowers. Packard thinks that the habit of feeding exposed, and living gregariously up to the time of pupation, proves the almost complete immunity enjoyed by this caterpillar from the attacks of birds.

An observation, very similar to that just recorded as made by Edwards, is noticed by Nicéville, who says (*Butterflies of Sumatra*, p. 401) that on one occasion, when Martin was collecting the larvæ of *Cethosia logani* on a passion-flower with red fruit, the latter noticed the protective position assumed by some of the caterpillars, which, in eating a twig, had surrounded it entirely, so that this little congerie of larvæ, even at a short distance, looked like one of the fruits.

The resemblance that the larvæ of *S. albifrons* and *C. logani* bear respectively to a raceme of flowers and a bunch of fruit is paralleled by the almost exact similarity that the gregarious larvæ of *Endromis versicolora* have, when young, to a bunch of birch catkins. It is the habit of the latter in the first two skins, to congregate at the end of the twigs of the birch, their heads raised and pointed towards the extremity of the twig. In this position, their resemblance to the young birch catkins is unmistakeable, for their dark coloration, coupled with the rough surface of the skin and the raised position of the anterior part of their bodies, makes them most difficult to distinguish, unless specially looked for.

We have already drawn attention to the fact that an undisturbed larva of *Stauropus fagi* bears a great resemblance to a beech-leaf. Mrs. Bazett has pointed out (*Ent. Rec.*, ii., p. 210) the great resemblance that the newly-hatched larva bears to an ant. Müller first drew attention (*Kosmos*, 1879, p. 114) to the fact, that an irritated adult larva of the same species assumes a spider-like attitude for the purpose of alarming its enemies. Poulton says that, when excited, the anterior, unlengthened legs are held apart, and certainly suggest the jaws of a spider-like animal, whilst the posterior abdominal segments are turned so far over the head that the two caudal appendages project over it, and, by divergence, occupy the appropriate position for a pair of antennæ, which, indeed, they suggest most strongly. The four elongated legs are extended widely and quiver in the most terrific manner, whilst the ventral surface of the larva, which becomes dorsal in the terrifying attitude, is coloured so as to resemble the abdomen of a spider-like creature. Poulton states that the result is to produce not exactly any particular spider, but only an ideal monster which embodies all the most alarming points in a spider's organisation.

The strange superficial resemblance that certain of the Chœrocampid larvæ bear to reptiles has been repeatedly noticed. A larva of a species of *Choerocampa*, from New Granada, is recorded (*Ent. Mo. Mag.*, vi., p. 172) as being remarkable for the extraordinary form of the head, which resembles that of one of the venomous snakes of that country.

Packard writes of the terrifying appearances observed in the larvæ of *Cerura* and *Stauropus*, as follows :—The *Cerura* larva varies in the direction of the enlargement of the prothoracic segment, to form a sort of hood to admit the head, serving to make a visage calculated to frighten away any assailant. It is the puff-adder among the Bombycine* caterpillars, as the larva of *Choerocampa* is among those of the Sphingids. The stemapoda, which seemed to have proved very useful in *Macrurocampa*, were retained in *Cerura*, being apparently too useful to be lost. While the *Cerura* caterpillars assume a defensive and offensive attitude, in order to frighten away other animals, they do not mimic the appearance of other animals; but in the singular caterpillar of *Stauropus* there is such a mimicry, the thoracic legs being much longer than in any other known lepidopterous larvæ and the stemapoda being thickened and shortened, so that when the creature throws itself into a sprawling grotesque attitude, with its tail up in the air, as remarked by Hermann Müller, it resembles a great spider. At the same time, the style of coloration is changed; it has not the green and red tints of *Cerura*, but is tinted light and dark horn-brown, like the bodies of many large spiders. In the case, then, of *Stauropus*, variation has gone on in a novel and determinate direction, the process of natural selection ending in a result not to be observed in the case of any other lepidopterous larvæ, the initial cause of variation being apparently the result of protection, due to a resemblance to members of another class of arthropods (*Bombycine Moths of America*, p. 31).

---

* We consider *Cerura* to be a Notodont genus, and do not look upon the latter as Bombycid in the true sense of the term.

It has been pretty clearly proved by recent experiments, that bright colours are readily distinguished by insects, and that the recognition of these, and of moving bodies, are the main features of insect vision. The value of mutant or moving tubercles, therefore, as a means of protection, is evident, and an ichneumon, or carnivorous beetle, or bug, may be frightened away if startled by a moving tubercle like those found on many larvæ.

We have previously referred to the protective structures of the larvæ of the *Schizurae*. That of *S. leptinoides* has, on the 1st abdominal segment, a high dorsal tubercle, that is both mutant and slightly retractile, being invaginated when the larva is irritated. Packard says: The movable, terrifying tubercle of the 1st abdominal segment of the larvæ of the *Schizurae* becomes developed shortly before the creatures are half-grown. He connects the development of these tubercles with the larvæ changing their hitherto concealed habit, to a more exposed position when feeding. The swollen, coral-red, dorsal hump on the 1st abdominal segment of the larva of *S. concinna*, to which we have already referred, can also be moved by the larva so as to terrify its enemies.

The presence of moving tubercles is not particularly well illustrated among the larvæ of our British lepidoptera, and those of *Apatura iris* are, perhaps, the best known. They are very prominently developed in the larva of *Anosia archippus*, which keeps the anterior flexible filaments constantly in motion backwards and forwards when eating, and moves them still more rapidly when alarmed.

Packard has pointed out that the large larval spines of some of the Saturniids are movable in the early larval stages. These spines are marvellously developed in some Saturniid larvæ. In that of *Citheronia regalis*, for example, there are, on each segment, six well-developed spines, and an additional large median spine on the 8th and 9th abdominal segments. The two large median spines, on the two hinder thoracic segments, are each about 20 mm. in length. The larger spines all end in a swollen, triangular, two-horned, flattened bulb, these appendages being deterrent, and for offensive use in the early, as well as the later, stages of larval life. Packard further states that the four pairs of prothoracic horns (or spines) in *Sphingicampa* are not held spread out as in *Citheronia regalis*, but those of each pair are constantly held close to each other. The horns and the six silvery, opalescent, shining tubercles (on the 5th to 10th abdominal segments) probably become terrifying by the movements of the larva. The latter are turned on, and throw their light out suddenly, like flashes, and may thus have a deterrent effect on their enemies. It is possible that the formidable spines of the grown-up caterpillar save it not infrequently from being swallowed by birds, though the younger larvæ appear to rely rather on their movement for scaring their enemies.

Closely allied to the mutant structures just described, so far as their protective value is concerned, are the eversible glands found in various caterpillars. One of the most general of these is the chin-gland. This is a swollen vesicle situated on the ventral side of the prothorax, just in advance of the first pair of legs. It is very generally developed in Noctuid, Notodontid and butterfly larvæ, and appears to be the remnant of an everted gland, and is probably homologous with the active weapon of offence found in the same position in the larva of *Cerura vinula* which has the power to eject from it, with considerable force, a quantity of formic acid. The chin-gland is found in almost all butterfly larvæ which do not possess osmateria. It is, usually, bladder-like and vesicular, is extensible, and can be protruded and withdrawn, and has been by some authors considered to have some connection with the osmateria of Papilionid larvæ. That the osmateria and chin-gland at one time had a somewhat similar function, is very probable, though it is difficult to explain why the latter should have degenerated so completely in some species. When withdrawn, the chin-gland presents only a transverse slit, similar to that left when the osmateria of the Papilionid larvæ are withdrawn. The chin-gland has been long known to entomologists, certainly as far back as Bonnet's time, a century and a half ago.

It may be well to examine, somewhat in detail, the chin-gland of *Cerura vinula*. This, like that of the allied species, *C. furcula*, consists of four lateral processes, two on each side, and a central sac, in which the irritant secretion is stored. The sacs can be readily pressed out in an almost full-fed larva. Poulton considers that the gland could originally have been everted voluntarily, but that the power has been lost since it has acquired the ability of secreting an irritant fluid. The fluid ejected by the larva of *C. vinula* has been chemically analysed, and has been found to consist of formic acid. It affects litmus paper strongly, and causes effervescence when it comes in contact with bicarbonate of soda. Crystals of formate of lead, obtained by collecting the secretion of the larva on 283 occasions, were exhibited at a meeting of the Entomological Society of London. The secretion had been mixed with distilled water, in which oxide of lead was suspended. The latter dissolved, and the acid of the secretion being in excess, the normal formate was produced (*Trans. Ent. Soc. Lond.*, 1887, p. xxxvi). It has also been recorded that the larva of *Stauropus fagi* ejects an acid fluid in a somewhat similar manner to that ejected by *C. vinula*, and that on one occasion it caused considerable pain, owing to the liquid being squirted in the eye (*Entom. Record*, iv., p. 32).

The osmateria of the Papilionid and Parnassid larvæ are found on the dorsal surface of the prothorax. Each consists of a bifurcate sac, which, ordinarily concealed within a cavity of the prothorax, and closed normally by a transverse slit, is suddenly thrust out when the larva is disturbed. As observed in the larva of *Papilio machaon*, it consists of two fleshy protuberances branching from a common stalk, is of an orange colour, eversible, gives out a strongly-scented odour (and a drop of clear liquid, according to Poulton) every time it is protruded. It is, in other species, usually brightly coloured, and exhales a distinct odour, the latter differing entirely, according to the species, scarcely perceptible, according to Scudder, in *Laertias*, and varying through all degrees of offensiveness, to a truly sickening stench in *Iphiclides*. The organ itself is really a development of the integument, with glandular cells at its base, their secretion being probably discharged through the cuticular pores, the odorous secretion accumulating in the invaginating horns, and being freed by their exsertion. When it is withdrawn, the osmaterium lies with one of its horns on either side of the body, extending backward to the 1st abdominal segment, according to Klemensiewicz, but to the 3rd, according to Studer, both of whom studied the organ in the larva of the same species, *Papilio machaon*. Both of these authorities agree that a delicate muscle is attached to the tip of each horn, which has its insertion, according to Studer, on the dorsal, but according to Klemensiewicz, on the ventral, side of the body. It is by this muscle that the osmateria are withdrawn, and this explains, not only why one branch may move quite independently of the other, but also why the invagination begins at the tip. The osmaterium is probably protruded by the muscular contraction of the walls of the body, forcing the contained fluids into the tube, and thus pressing out the reversed osmaterium.

Probably the most frequently studied of the eversible glands of larvæ are the well-known flagella of *Cerura vinula*. These flagella are very long, and can be thrown out and withdrawn by the larva with great rapidity. In the process of evagination, the filament, which lies in a receptacle, unrolls from the base, so that the apex is the last part to appear. When invagination takes place, the apex first disappears followed by the remainder. When the flagellum is half its original length, the apex, which is passing in, is on a level with the base of the structure when it is fully evaginated, the remainder disappearing until the flagellum has been completely drawn inside the base. Poulton writes :—" At the base of each flagellum there is a small transparent area extending round the whole circumference, and through this, as through a window, the processes of evagination and invagination can be readily watched. When the invaginating flagellum has shortened to half its length, the tip has, of course, been drawn inwards as far as the transparent base, and a pink line is seen in the axis of the latter, rapidly lengthening inwards, until the whole axis is pink. As invagination becomes complete the pink axis disappears inwards as the transparent part is itself invaginated. The same phenomena are also seen in evagination in the reverse order. The protrusion and withdrawal of the claspers (prolegs) seem to be essentially due to the same process" (*Trans. Ent. Soc. Lond.*, 1885, p. 322). When, by any means, the rim of the receptacle (base of flagellum when everted) is injured, the flagellum often becomes permanently introverted, and it can then be seen within the receptacle. It can also be everted by forcing blood into it. The arrangement of the nerves and muscles relating to these organs is figured by Poulton (*Ibid.*, 1887, pl. x., fig. 9). The power of contraction in the retractor muscles of the flagella is enormous.

Speaking of the manner in which the anal prolegs have been modified into stemapoda, with their attendant flagella in allied genera, Packard says : The hypertrophy of the anal legs once initiated became accelerated, until, in the larva of *Macrurocampa*, it culminated in a pair of anal filaments, with their evertible flagella as fully finished as in *Cerura*, the larva using these in the same manner as deterrent structures (*Bombycine Moths*, etc., p. 31).

The larva of *Pirachola isocrates*, the well-known Pomegranate butterfly, is said by Pargiter to have two white spots near the anal end, in each of which is a small horn-like process, which the larva continually protrudes and retracts. This observer, however, confused these eversible structures with the honey-gland on the dorsum of the 7th abdominal segment of certain species, and which is so attractive to ants. Nicéville gives (*Butts. of India*, vol. iii.) an excellent account of two tubercles with protruding flagella, found one on each side of the 8th abdominal segment of *Curetis thetis*. These are described as two diverging, cylindrical, rigid pillars, arising from the sub-dorsal region, and of a pale green colour. When the insect is touched or alarmed, a deep maroon tentacle, as long as the rigid pillar, bearing on its end long particoloured hairs (the basal third black, and upper two-thirds white) is everted. The maroon tentacle, with its long hairs spread out like a circular fan or rosette, is whirled round with great rapidity in a plane parallel to its body, its use being, almost certainly, to frighten away its enemies. Similar eversible glands are described by Hagen as occurring in the larvæ of *Plebeius argus* and *Polyommatus corydon*. He writes: "You find on the penultimate segment, outside and behind the stigmata, two large white spots, each of which evaginates a white membranous tube, just like the finger of a glove, the tip of which is not entirely drawn out." Exactly what measure of protection is afforded by these flagella is not known. They are by no means generally present among Lycænid larvæ, closely allied species often differing in this respect. Many authors (including Dimmock and Scudder) incline to the opinion that they are of the nature of osmateria, and diffuse odours, but the supposition is altogether without support, so far, that at present, no such odours have been detected.

On the dorsum of the 6th and 7th abdominal segments of many Liparid larvæ, are to be found (after the first moult) a pair of eversible glands. In the larvæ of *Dasychira pudibunda* and *D. fascelina*, however, only one gland is present, *viz.*, that situated in the medio-dorsal line of the 7th abdominal segment, which becomes everted when the larva rolls up on being disturbed. Poulton states that the larval surface, close to the lips of the aperture, seems to be extremely sensitive to tactile impressions. He also describes (*Trans. Ent. Soc. Lond.*, 1886) two medio-dorsal, orange-coloured glands situated towards the anterior margins of the 6th and 7th abdominal segments in *Porthesia similis* (*auriflua*) capable of secreting a pale transparent fluid, which Swinton believed was poisonous, but which Poulton finds to be odoriferous. Bacot says that the eversible glands are very active in the larva of this species, and are far more frequently seen in operation than in other Liparid larvæ. All the British species of the Liparids appear to possess these glands except *Demas*, although, as we have seen, *Dasychira* only possesses one of them. Bacot points out that, in addition to these, the larvæ of *Psilura monacha* and *Porthetria dispar* have a small yellow gland on the first four abdominal segments, placed one on each side of the medio-dorsal band; he has, however, not observed any movement in these. He also notices that the larva of *Leucoma salicis* has, similarly, a pair of small, round, flask-shaped glands, placed close together near the centre of the 1st and 2nd abdominal segments, and which, in later stages, exude a drop of clear, viscous-looking fluid.

It would appear that these glands are pretty generally distributed among the Liparid moths. Poulton says that in the larvæ of certain Indian Liparids they are usually present. He found two glands on *Lymantria concolor*, which he considers closely allied to *L.* (*Psilura*) *monacha*. They were also found in *Chaerotricha plana*, *Charnidas exclamationis*, *Artaxa vitellina*, *A. scintillans*, *A. guttata* and in *Dasychira dalbergiae*, although he failed to detect them in a few Indian larvæ belonging to this genus. He says that the character is probably almost co-extensive with the family, and that the single gland of our two British species of *Dasychira* helps to unite these in a single genus. All these eversible glands are "pleurecbolic" and "acrembolic," like the flagella of *Cerura vinula*, and all must possess an axial retractor muscle.

Patton writes (*Can. Entom.*, xxiii., pp. 42-43) that he found some Limacodid larvæ on liquid-ambar, which, when disturbed, had the power of emitting drops of clear liquid from pores along the edges of the back, the fluid having an odour similar to that of crushed liquid-ambar leaves. The pores from which this fluid is secreted are sixteen in number, situated along the edges of the back, their location being indicated by darker green spots just below the edge. The odour is probably protective.

In the same way, the remarkable, tubular, fluid-bearing hairs, previously referred to (*ante*, p. 51), as being common in many larvæ, are supposed by Scudder to have a protective value. He writes: They are usually arranged in longitudinal rows, and their use is wholly unknown. They are a universal characteristic of all butterfly caterpillars in their earliest stage, excepting, probably, the larger part of the highest family, but are common in the later stages of some of the lower families. They are papilla-mounted bristles, each furnished with a trumpet-mouthed tip, and are the ducts leading from glands at their base, secreting a transparent fluid, which, after secretion, is borne in a little globule in the mouth of the trumpet, and sometimes kept in its place by a few microscopic bristles which surround its rim. It probably has a protective function, and is odoriferous, the secretion increasing when the larvæ are disturbed.

Chapman notes that the larva of *Jocheaera alni* gives off an odour that closely resembles coal-gas. We believe nothing is known as to where the odour is produced, nor of the glands that set it free.

We have already described certain eversible glands with flagella-like structures on the 8th abdominal segment of certain butterfly larvæ. Another gland found on the dorsum of the 7th abdominal segment is important as secreting a sweet fluid, which is much sought after by ants, and in return for which the larvæ are protected by the ants from predaceous enemies. Scudder says that all Lycænid larvæ have the slit on the 7th segment, though all do not possess the gland. In those larvæ that do possess it, a vesicular gland of somewhat tubular shape is thrust frequently through a transverse slit on the dorsum of this segment. Esper was the first to notice the relation of the larva and the attendant ants. Freyer figures the glands as two white dots in *Plebeius argus*, but does not describe them. The glands are stated to be present in the larva of the European species, *Thestor ballus*. Anderson says (*Victorian Butts.*, pp. 101-102) that the larvæ of the genus *Ogyris* are greatly attractive to ants, which tend them with great care, never leaving them. He further notes that the pupæ of this species are often found in ants' nests, the larvæ having pupated there, that the attended larvæ are rarely attacked by parasites, but that *Ogyris olane*, a non-attended species, suffers severely from the attacks of parasitical diptera. Scudder has described the attendance of the ants on *Cyaniris pseudargiolus* in detail. Perhaps the most remarkable thing that strikes one is that this American species is so close to the European *C. argiolus* that it might be regarded only as a form of that species, yet the larva of the latter has never been described as protected, or possessed of any traces of the associated structures. The European *P. argus*, too, belonging to quite a different section of the Lycænids, has structures almost identical with those of *C. pseudargiolus*, and is protected by ants in precisely the same way; yet *P. aegon*, in many respects indistinguishable from *P. argus*, has no such habit, although it has apparently some traces of the structures.

The actual gland from which the honey is obtained is situated on the dorsum of the larva, and looks like a transverse dorsal line on the 7th abdominal segment. The larvæ of *P. argus* and others attended by the ants, may easily be detected, owing to there being around them constantly a group of ten or twenty ants. Edwards has detailed how he saw the ants drive off an *Anomalon*, that would otherwise have attacked a larva of *C. pseudargiolus*, so that there can be no doubt that the ants protect the larvæ, and in return utilise the sweet secretion exuded from this dorsal gland.

Eversible glands of an offensive nature are said to be present in some Eucleid larvæ. Of these, the so-called "stinging spines" of *Doratifera vulnerans* are the best known. This species is described as possessing the power to evert eight little tufts of stinging spines, which are concealed when the larva is not irritated. Dyar says that these eversible spines (horns) are hypertrophied warts on joints 4, 5, 11, 12 (? 1st, 2nd, 8th and 9th abdominal segments), whilst in *D. lewini* and *D. casta*, the two front ones only are present. These retractile organs consist of a short fleshy shaft with numerous spines, which bend inward over the back, the spines becoming converged, and the whole concealed by a triangular fold of skin.

Some species appear to have more than one mode of protection against their enemies. The accumulative protection afforded to the larva of *Basilarchia arthemis*, by its colours, tubercles, habits, etc., is narrated at length by Scudder. He says: "Dark and light green and cream colour strive for the mastery, and leave it streaked and blotched, so that it bears no inconsiderable resemblance, in colour at least, to the droppings of some birds, a circumstance which, doubtless, serves it as some sort of protection. Its body is humped, and the bosses bear tubercles, which give it a somewhat repulsive aspect, especially a pair a little behind the head, which are raised aloft, and thickly studded with prominences, the effect of which is heightened by the creature's habit of arching this part of the body, bending its head to the ground and raising aloft its hinder part, also studded with roughened processes. Altogether, it is a rather hideous beast. Then, too, if disturbed, it raises the front half of its body from the ground and uses it as a kind of whip-lash, throwing it from one side to the other with great violence. When it walks, it moves with a slow and cautious tread, its head trembling as if it had the palsy. All this is doubtless to inspire fear in such enemies as might be tempted to attack it."

The excretions of larvæ are of considerable importance in forming a means of defence. It is a very prevalent practice, amongst some larvæ, to eject from the mouth a fluid, usually, but not necessarily, of a bright green colour, as soon as they are touched. This fluid is secreted most freely among the Vanessids, Tortricids, Lasiocampids and Geometrids, and its wide-spread occurrence points to it as an effective weapon for their protection.

Many Sphingid (and other) larvæ—*Smerinthus populi*, *Macroglossa stellatarum*, etc.—have a habit, when quite full-grown, of "licking" themselves on the dorsum, and, whilst so doing, they spread a fluid over the surface of the back. It has been observed that the "licked" portions of the body are those that change colour, and the fluid may have some action on the chitin, that brings about this change. If so, it is a very useful means of protection, for, at this time, the usually green Sphingid larvæ leave the green leaves of their food-plant, and crawl for a considerable distance over the surface of the ground (where their normally green colour would be exceedingly conspicuous) to find a suitable place for pupation. It has been suggested, however, that the fluid is used as a protection against ichneumons, the larvæ being, just previous to pupation, in a most helpless condition.

So far as our observations go, this fluid appears to be of the same nature as that used by various larvæ (*Eriogaster lanestris*, etc.), for the coloration of their cocoons. The fluid comes from the alimentary canal, and appears to contain a modified form of chlorophyll. The fact that those portions of the body on which the fluid is rubbed, turn red, or purple, or brown, suggests that the change may be due to the oxidation of the chlorophyll-extract present in the fluid.

The inedible nature of hairs has been already remarked upon. The spinose character of certain larval hairs is very marked, the main shaft often bristling with numberless, minute, lateral points. These hairs are very general in many families, the Anthrocerids, Liparids, Arctiids, etc. Such hairs must produce great irritation if they enter the epithelial lining of the alimentary canal of an entomophagous bird or mammal. The effect of the urticating hairs of certain Liparid and Lasiocampid moths is within the knowledge of every entomologist.

Many larvæ, notably those of the Liparids, have tussocks, or tufts of these fine, spinose hairs, often so dense that the combined effects of these hairs, if inadvertently swallowed, might be very serious. The easy manner in which they can be pulled out also aids in disseminating them if they once enter the mouth. When irritated, tussock-bearing larvæ usually bend themselves so as to throw up prominently these bristling tufts, and a hasty enemy finds its mouth filled with loose hairs instead of the tasty morsel it had expected. Insect-eating animals must undoubtedly learn, by experience, what is edible and what is not, and a first attempt at a hairy larva is likely to be a last with any tender-mouthed creature. Dozens of observers have noticed the fact that various insect-eating birds and mammals have refused hairy and spiny larvæ, even when hungry.

Some Liparid larvæ, when alarmed, not only elevate their bristly tussocks, but also, at the same time, expose a series of intensely black intersegmental rings which, not at all conspicuous when the larva is in repose, become so when it is disturbed. These help to make the tussocks still more conspicuous. If such larvæ are much disturbed or attacked, they roll into a complete ring, the projecting tussocks standing out as a bristly armature all round the body, and expose to the full the black intersegmental membranes. Poulton's observations on the larvæ of *Orgyia antiqua* and *Dasychira pudibunda*, when attacked by hungry lizards, led him to believe that their tussocks would preserve the larvæ, except in the case of a very hungry enemy.

The urticating hairs of *Lasiocampa quercûs* form the short dorsal fur of the larva, and are used to mix with the silk of the cocoon, masses of them often lying loose in the outer web by which the cocoon is attached to the twigs, etc., among which it is spun. They also stand out directly from the cocoon proper, and hence careless handling of the cocoon is almost sure to result in breaking off some of the fine points in the skin. The urticating hairs of *Macrothylacia rubi* appear to be very similar to, if not identical with, those of *L. quercûs*.

So far as our experience goes, urtication is purely the result of the mechanical action of the hairs, but Swinton says that they are not merely mechanical, and that the hairs are poisoned by a caustic liquid issuing from the scarlet tubercles on the hinder segments of *Porthesia similis*. This liquid has, however, been shown by Poulton to be odorous. Bacot says that the urticating hairs of *Porthesia similis* and *P. chrysorrhoea* are much smaller than those of *L. quercûs*, about one-third to one-fourth of the length, and are much more complicated in structure, being spinose, and with the base divided into three prongs. In *Porthesia*, they appear to be developed only on the tubercles, but in the Lasiocampids, the dorsal and sub-dorsal areas of the larvæ are coated with them. He also agrees that their action is simply mechanical.

As it is not our intention to refer to the defensive properties of hairs at greater length, we would call attention to the fact that all spines or prickles serve to protect the organism from external attack. They do not, of course, prevent many larvæ being eaten, but they prevent many animals preying upon them that might otherwise do so. They are, therefore, to be considered as adaptive structures, and have been developed from more simple, previously existent, structures, in response to necessities, most probably arising from the attacks of entomophagous animals. The changes that have occurred, therefore, in the simple setiferous tubercles, or hairs, or in the minute body hairs or pile, by means of which they have been respectively changed into defensive spines, or fascicles, or into a dense hairy coat for protective purposes, form a very interesting and instructive line of study.

Before concluding this chapter, it may be well to call attention to an act of strict commensalism occurring among caterpillars. The occurrence is recorded by Fritz Müller, as taking place in South America, between a large spiny caterpillar, which was almost invariably found to be accompanied by a small hairy caterpillar, so small as to rest securely in a transverse position across the back of its good-natured host, well concealed among its spines, and it is stated that the skin of the host was hardened at the place where the smaller larva rested. One is puzzled to know exactly what advantage this companionship would be to either larva, except that the spines of the larger caterpillar might prove a sufficient protection to the smaller, as well as to itself.

On the other side of the question, *viz.*, that in which the lepidopterous larva is the attacker, and not the attacked, we learn from Nicéville that the Indian *Spalgis* is very like the American *Feniseca*, since the larvæ of both are carnivorous, associating with and feeding upon the "mealy bug" of the planters, a species of *Dactylopius*.

Besides the protection offered, by the various means already detailed, to larvæ against their enemies, some remarkable instances of protection against abnormal meteorological conditions are recorded. One of these is recounted at length by Nicéville (*Butts. of Sumatra*, p. 538), and refers to the larva of a Hesperid, *Erinota thrax*, which is covered with a white waxy powder, and lives in a shelter made of a portion of one of the enormous leaves of *Musa*, which it cuts into in order to obtain a suitable segment for its shelter. The pupa is covered with the same white powder as is the larva, and is quite hidden from view in its dining-room. This powder is of the greatest service to the animal as, in consequence of the heavy showers of rain in the tropics, much water often collects in the rolled-up leaf, and the pupa, if not so protected, would soon be drowned and rot. As it is, the powder keeps the pupa dry until the water has drained away or dried up. The downy larva of the allied *Gangara thyrsis* is similarly covered with a white waxy powder. There is no doubt that the wax with which these larvæ (that live in closed habitations) are covered, is of the same value as that with which the pupa of *Parnassius apollo* and others are coated, *viz.*, to protect the larva (and pupa) from damp.

We have previously referred to the passive defence offered by all lepidopterous larvæ, and the reason of this is not far to seek. The peculiar form and character of these larvæ lend themselves very readily to injury. The larva cannot reply to its enemies in any way in which the combat would resolve into a question of mere physical strength. A small injury is almost as dangerous to it as a great one, and the loss of blood resulting from a slight wound usually proves fatal. It is probably owing to this that the various means of protection found in larvæ are almost always of a passive kind. Such means of defence as they have are almost entirely such as tend to prevent them from being seen or touched, rarely such as are of any real service when they are actually attacked. In some larvæ there may be various modes, or changes in the mode, of defence, but the object is always to leave the larva untouched, a touch being practically fatal to it. The larva of *Stauropus fagi*, at rest, resembles a beech leaf. If disturbed, it adopts a terrifying attitude, but if this be of no avail, the larva possesses no other means of protection. The larvæ of Geometrid moths resemble pieces of stick; when disturbed, many fall to the ground, but if followed up here their means of defence are exhausted. The larva of *Choerocampa elpenor* is protected by its similarity to its food-plant; if disturbed, it takes on a terrifying attitude, but again, if this fail, it has no further means of protection. Warning colours, and unpleasant or pungent secretions, are of no use against foes that once attack the larva, for the slightest injury would prove fatal, even if the attacker found the prey inedible after capture. It is quite possible, therefore, that the very perfect resemblance which larvæ bear to their surroundings, so perfect as often to render them practically invisible, as well as the development of long tussocks of dense hair, that is so loose that it is shed without injury to the larva almost as soon as touched, and also the formation of huge spiny structures, have all been brought about in preference to offensive structures, because the exceeding delicacy of structure of the larva would prevent it taking any active part in any physical attempt to combat the attacks of its enemies. Such offensive measures as are occasionally adopted, *e.g.*, the syringe of *Cerura*, are so very exceptional, that they can almost be neglected from the consideration of the general question. The development of mutant tubercles and flagella are probably meant only to startle ichneumons that injure and attack the larvæ in quite another way, whilst protective coloration, and, indeed, all forms of passive defence, alone are used against their physically stronger foes.

There can be, we think, little doubt that all the purely defensive structures of insects—hairs, flagella, glands, etc., have been developed in response to the increasing attacks of enemies. That we know very little about the subject is very evident, and workers have here an unlimited field for observation. Almost every specialised larva responds in some particular way to its environment, and here the field naturalist has the whole domain to himself. Each peculiar structure has its own particular use, and it is only by observing closely the habits of the animal in nature, that the use can be learned. It requires great skill, power of observation, and unbounded patience, but it is a work that will repay the labourer with interest, for all the care he may bestow upon it.

CHAPTER IX.

CLASSIFICATION OF LEPIDOPTERA.

PROBABLY nothing relating to the Lepidoptera has undergone such a complete revolution during the last decade as our notions of the classification of the order, and, to a great extent, our views are governed by the observations of a few workers, of whom Chapman, Comstock, Dyar and Packard are the chief. In a paper "On the Classification of Lepidoptera"* we ventured the opinion that "no scheme based on a single set of characters belonging to only one stage of an insect's existence could possibly be even approximately perfect. It is possible to conceive that, especially in those orders in which the methods of life differ so greatly in the various stages, and different means of defence and protection are thus rendered necessary, an insect may be very greatly modified in one particular stage, without any corresponding modification in the other stages being at all necessary. It may happen to be of advantage for the larva to be of a generalised type, and for the imago to be much more specialised, or *vice versâ*. If this be granted, it follows that no scheme of classification that is not founded upon a consideration of the structural details and peculiarities of the insects in all their stages can be considered as really sound, or as founded upon a natural basis. It is also evident that the results of the various systems—whether based on oval, larval, pupal or imaginal characters—must be compared, and the sum total of evidence brought together, if a satisfactory result is to be obtained." It is on these lines that we have attempted to base the system of classification adopted in this work.

---

* *Trans. Ent. Soc. London*, 1895, pp. 343 *et seq.*

In the determination of the relationships existing not only between the stirpes themselves, but between the superfamilies of each stirps, considerable literature has had to be digested, and the results compared with our own knowledge of the living insects. The points to which attention has been directed and the literature that we have found most useful for our purpose are as follows:—I. THE EGG.—By far the best (we may say the only) work on the characters presented by the lepidopterous egg, is Chapman's paper, "The phylogeny and evolution of the Lepidoptera from a pupal and oval standpoint."[1] Since the publication of this paper, we have examined the eggs of some three or four hundred species of Lepidoptera, belonging to different families, and find his conclusions corroborated. II. THE LARVA.—Here we are chiefly indebted to (1) Dyar's "Classification of lepidopterous larvæ,"[2] "Additional notes on the classification of lepidopterous larvæ,"[3] "A combination of two classifications of Lepidoptera,"[4] and "Relationship of *Pyralidae* and *Pterophoridae* from the larvæ."[5] "Larvæ of the Higher Bombyces."[6] (2) Chapman's "Observations on larval prolegs,"[7] "Notes on Micro-Lepidoptera, whose larvæ are external feeders."[8] (3) Packard's "Study of the transformations and anatomy of *Lagoa crispata*, etc.,"[9] "Life-history of certain moths of the family *Cochliopodidae*,"[10] "Life-histories of certain moths of the families *Ceratocampidae*, *Hemileucidae*, etc.,"[11] and many other papers. (4) Poulton's "On the ontogeny of *Sphinx convolvuli* and *Aglia tau*,"[12] and various less important papers by other authors. III. THE PUPA.—Chapman and Packard alone here give real help. (1) Chapman's papers are, "On a lepidopterous pupa with functionally active mandibles,"[13] "Notes on pupæ, etc.,"[14] "On *Alucita hexadactyla*, chiefly in relation to the structure of the pupa,"[15] "On some neglected points in the Heterocerous pupa,"[16] as well as "The phylogeny and evolution of the Lepidoptera from a pupal and oval standpoint," to which we have already referred. (2) Packard's "New classification of the Lepidoptera."[17] IV. THE IMAGO.—We have had access to all the leading papers on this subject, Comstock, Hampson, Kellogg, etc.

---

[1] *Trans. Ent. Soc. Lond.*, 1896, pp. 567 *et seq.*

[2] *Ann. New York Acad. Sci.*, viii., pp. 194 *et seq.*

[3] *Trans. New York Acad. Sci.*, xiv., pp. 49 *et seq.*

[4] *Journal New York Ent. Soc.*, 1895, pp. 17 *et seq.*

[5] *Entom. News*, Feb., 1895.

[6] *Proc. Bost. Soc. Nat. Hist.*, xxvii., pp. 127 *et seq.*

[7] *Trans. Ent. Soc. Lond.*, 1893, pp. 97 *et seq.*

[8] *Ibid.*, 1894, pp. 335 *et seq.*

[9] *Proc. Amer. Phil. Soc.*, xxxii., pp. 275 *et seq.*

[10] *Ibid.*, xxxi., pp. 83 *et seq.*

[11] *Ibid.*, pp. 139 *et seq.*

[12] *Trans. Ent. Soc. Lond.*, 1888, pp. 515 *et seq.* [13] *Ibid.*, 1893, pp. 255 *et seq.*

[14] *Ibid.*, 1896, pp. 129 *et seq.* [15] *Entomologist's Record*, etc., vii., No. 11, 1896.

[16] *Trans. Ent. Soc. Lond.*, 1893. [17] *Bombycine Moths of America*, 1895.

The conclusions to which we have come concerning the characters considered by various authors as important may be briefly stated as follows: (1) *The jugum.*—As Chapman has already pointed out, this is "the remnant of a wing-lobe, well developed in many Neuroptera, and appears to have no such function as is attributed to it (*i.e.*, of combining the wings in flight)." The hindwing of *Micropteryx* (*Eriocrania*) has "also an external lobe or 'jugum'" (Packard). The classificatory value of the jugum, by which Comstock separates the whole order Lepidoptera into JUGATÆ and FRENATÆ, therefore, is such as to shut off the two or three most generalised superfamilies, such separation giving us no clue whatever to the more specialised superfamilies that have risen from the stirps, of which these are now the lowest representatives. (2) *The frenulum.*—Chapman has pointed out that one of the superfamilies (MICROPTERYGIDES)* placed with the JUGATÆ, has also distinct traces of a commencing frenulum in the development of some strong hairs; whilst Kellogg finds† in the Trichopterygid genus *Hallesus*, "the beginning of the frenate method of wing-tying," there being "present, on the base of the costal margin of the hind-wing, two long, strong hairs, the very counterpart of the generalised frenulum (*i.e.*, frenulum in which the hairs are not united into one single strong spine) of the lepidopterous wing." That the frenulum had its origin much lower than is usually assumed, *e.g.*, in Trichoptera, and, therefore, probably in Lepidoptera, before they were differentiated as such, leads us to suppose that, possibly in the earlier Lepidoptera (now extinct), many frenate and jugate families, otherwise closely related, ran on side by side. Of the latter, only the Micropterygids, Eriocraniids, and Hepialids are left, and these, although retaining this primitive trait, have become greatly modified in other directions. It seems somewhat forced to attempt to derive the FRENATÆ directly from the existing JUGATÆ, now that Kellogg has shown that the frenulum in a generalised form also exists in Trichoptera. That it has always been a very variable and plastic structure, is evident from its present erratic occurrence and absence in allied species. So uncertain is its occurrence that, in order to carry out Comstock's division of the Lepidoptera (except JUGATÆ) into GENERALISED-FRENATÆ and SPECIALISED-FRENATÆ, other characters (chiefly from neuration) have to be called in. (3) *Neuration.*—It is now generally accepted that the most generalised superfamilies exhibit the most complicated system of neuration, and that the more reduced in number the nervures become, the more specialised is the family, superfamily, etc. This, with certain limitations (unneces-

---

* During the progress of this work through the press, a change in the usual nomenclature of this group has been made. The genus *Micropteryx*, Hb., is now said to be synonymous with *Eriocephala*, Curt., and therefore the superfamily MICROPTERYGIDES of this chapter = the superfamily ERIOCEPHALIDES of Chapter I. of this book. It has also been pointed out that *Eriocrania*, Zell., is the only name available for the genus that has been until now called *Micropteryx*. The superfamily name ERIOCRANIIDES will, therefore = the MICROPTERYGIDES of Chapter I. of this work. *Micropteryx* and the MICROPTERYGIDES will, in the following part of this work, refer to the "*calthella* group," *i.e.*, to the imaginal pollen-eaters and larval moss-feeders; whilst *Eriocrania* and the ERIOCRANIIDES will refer to the "*purpurella* group," with leaf-mining larvæ and pupæ with active jaws.

† *American Naturalist*, 1895, p. 715.

sary to enter into here), we consider to be generally true. The neuration of the Micropterygids (Eriocephalids), Eriocraniids and Hepialids is, perhaps, more generalised than that of any other Lepidoptera. Broadly, on these lines, the neuration allows us to separate the more generalised from the more specialised superfamilies. When, however, one comes to detail, *i.e.*, to the consideration of the characters arising from the modification of the neuration, we find the characters to be so variously interpreted and applied by different authors, that, standing alone, the neurational characters appear to be of very little value, witness Hampson's groupings,* by which—on the character that the "Forewing has nervure 5, arising from the middle of the disco-cellulars or nearer 6 than 4, the nervures not arising at even distances around the cell"—the *Cymatophoridae*, *Notodontidae*, *Geometridae*, *Uraniidae*, *Bombycidae*, *Ceratocampidae*, *Saturniidae*, *Sphingidae*, *Dioptidae*, *Epiplemidae*, *Epicopeidae*, *Eupterotidae*, *Brahmaeidae* and *Rhopalocera*,† all find themselves in one group. (4) *Movable incisions of pupa.*—Chapman's pupal characters of movable segments, divide off sharply, and with definiteness, the generalised, from the specialised, superfamilies, the INCOMPLETÆ representing the former, the OBTECTÆ, the latter, but it is only in the details, such as those of the dorsal head-piece, the maxillary palpi, etc., that we get any clue to the real relationships of the superfamilies to one another, although the amount of incompleteness of the pupa (*i.e.*, the actual number of movable segments) affords, in a comparative sense, valuable aid. (5) *Hooks on prolegs.*—The arrangement of the hooks on the larval prolegs is largely associated with a concealed or exposed habit of life, yet, with scarcely an exception, the character is sound in separating the generalised from the specialised superfamilies, and it is remarkable that even when a species belonging to one of the specialised superfamilies, reverts to a concealed mode of life, the prolegs do not revert to the generalised, but maintain the specialised, proleg structure. (6) *Larval tubercles.*—The arrangement of the tubercles is remarkable from the fact that, more than any other larval structure, they have undergone modification for protective purposes. In concealed-feeding larvæ, the tubercles have usually remained simple, the setæ often being suppressed until they form mere points on the chitinous button of the tubercle. On the other hand, in exposed-feeding larvæ, they vary from entire absence (where their presence would interfere with the protective coloration adopted by the larva), to raised warts bearing many setæ, or they may form a prolonged spiny base bearing several setiferous branches, or develop fascicles of urticating spines, or hairs may arise from the normal base. In spite of this, however, two characters remain fairly constant: (1) Tubercles i and ii tend to form (by union or by the atrophy of i or ii) a single subdorsal wart, or, on the other hand, tend to become arranged as anterior and posterior trapezoidals. (2) Tubercles iv and v both remain as sub-spiracular tubercles, or, on the other hand, v remains as a subspiracular, and iv becomes a post-spiracular tubercle. We do not think the pre-spiracular tubercle (which is more or less adventitious) of much value in classification, but the two above characters appear to be so.

---

* *Annals and Magazine of Nat. History*, Oct., 1894, pp. 254 *et seq.*

† This must be really a very specialised character, for, sifting the families here mentioned, one obtains the *Cymatophoridae* and *Geometridae*, the most specialised of the Geometro-Eriocraniid stirps; the *Bombycidae*, *Ceratocampidae*, *Eupterotidae*, *Saturniidae* and *Sphingidae*, the most specialised of the Sphingo-Micropterygid stirps; and the *Notodontidae* and *Rhopalocera*, specialised families of the Noctuo-Hepialid stirps.

Now it is evident from the above brief summary, that the structure of the larval prolegs, the characters offered by the movable pupal segments, the broad characters of neuration, and of the jugum, only help us to separate, as it were, the generalised from the more specialised superfamilies. These characters still leave them unsorted, and give us no clue to their relationship to each other.

We are not alone in our objection to the division of the Lepidoptera into the two sub-orders, JUGATÆ and FRENATÆ, as proposed by Comstock. Packard considers that the characters used are too slight, and do not agree with the more fundamental pupal characters, or with important imaginal features. He says: "The jugum is of slight, if of any, functional value, and, in *Micropteryx* (*i.e.*, *Eriocrania*), as in Trichoptera, occurs both in the hind- and front-wings, a point apparently overlooked by Comstock. The Hepialids are much less generalised forms than the Eriocephalids (*i.e.*, Micropterygids), or even the Micropterygids (*i.e.*, Eriocraniids); the pupæ of both these groups have free limbs and abdominal segments, belonging to what Speyer calls a group of 'Pupa libera.' The *Hepialidae*, also, possess neither maxillary palpi nor vestigial mandibles; they are borers in the larval state, and the pupa has not free limbs, but is a 'Pupa incompleta.' They are scarcely ancestral, though very primitive, forms, but have already become modified, having no traces of mandibles and no maxillæ, and, in the American species, the labial palpi have already begun to degenerate. We, therefore, scarcely see good reason for placing the family at the very foot of the order, below *Micropteryx* (*i.e.*, *Eriocrania*), but should regard the family as a side branch of the Palæo-lepidoptera, which, very soon after the appearance of the order, became somewhat specialised. Comstock's FRENATÆ comprise a heterogeneous collection of families, some of which have no frenulum at all, and, when the frenulum is present, they offer secondary sexual characters. The absence or presence of a frenulum is hardly, then, a sufficiently fundamental character to be used in establishing a great primary division. Besides this, there is a rather close alliance between the *Hepialidae* and *Cossidae*, the latter having a rudimentary frenulum. Chapman remarks, that while *Cossus* and *Hepialus* are quite distinct in pupal characters, there appear to exist in Australia many forms uniting them with *Zeuzera* into one family. The neuration is also quite similar, and while the two families of *Cossidae* and *Hepialidae* are, in some most important respects, quite far apart, one being, so to speak, Tineid, and the other Tortricid, in structure, yet it would, we think, be a forced and unsound taxonomy to assign them to different sub-orders" (*Bombycine Moths of America*, p. 57).

We have the same objection to Packard's own primary sub-division of the Lepidoptera into two sub-orders: I. The LEPIDOPTERA-LACINIATA or PROTO-LEPIDOPTERA [comprising only the Micropterygids (*i.e.*, Eriocephalids)]. II. The LEPIDOPTERA-HAUSTELLATA sub-divided into: 1. *Palaeo-lepidoptera* [comprising only the Eriocraniids (*i.e.*, Micropterygids)]. 2. *Neolepidoptera* (comprising the whole of the *Incompletae* and *Obtectae*). Such a sub-division, in spite of the elaborate diagrammatic table* that supplements it, gives us but little practical help in our knowledge of the broad lines of evolution along which the Lepidoptera have travelled. Unfortunately we are not able to follow the table, even in its broadest lines, for reasons that are self-evident, *e.g.*, the derivation of Pyralids from Pterophorids, and the latter from Alucitids, which Chapman has shown† to be impossible; the derivation of Lasiocampids from Lithosiids, and Notodonts from Lasiocampids, which the eggs show to be equally impossible, and so on.

It is quite evident that the evolution of the many specialised superfamilies has taken place from the generalised, and that the former are the most recent evolutionary products of certain stems of which the generalised are the older offshoots. What is needed, then, is some character (or characters) that will not slice off horizontally, as it were, all the branches of the genealogical tree, leaving (1) the upper superfamilies, composed of the OBTECTÆ or SPECIALISED-FRENATÆ, and (2) the lower, comprising the INCOMPLETÆ or GENERALISED-FRENATÆ, but one which will give us clues as to the development of the branches themselves vertically, and separate into their own particular branch the specialised and generalised superfamilies belonging thereto. In this way alone can we get a true conception of the genealogical relationship of the various families to each other.

It might have been supposed that Dyar's studies of the larval tubercles would have led him to have constructed a tree satisfying the necessary conditions, but it has not done so. One of his latest‡ (if not the latest) pronouncements on the subject, satisfactory as it is in many ways, leaves us much as we were. It works out as follows:—

I.—Tubercles iv and v approximate or consolidated.	
1.—Tubercles i and ii remote	MICROLEPIDOPTERA.
2.—Tubercles i and ii consolidated	ANTHROCERINA.
3.—Tubercles i and ii remote, ii disappearing at the first moult	BOMBYCINA.
II.—Tubercles iv and v remote.	
1.—Tubercle iv behind the spiracle, v below it ..	NOCTUINA
2.—Tubercle iv below, v in front of the spiracle	SPHINGINA.
3.—Tubercles iv and v in line, except in some *Nymphalidae*, where secondary armour is developed	RHOPALOCERA.

From this Dyar gets the following groups:—

I.—The MICROLEPIDOPTERA, including the *Psychidae, Cossidae, Pyralidae, Tortricidae, Sesiidae, Tineidae and Lacosomidae.*

II.—The ANTHROCERINA, including the *Pterophoridae, Anthroceridae, Pyromorphidae, Megalopygidae* and *Eucleidae.*

III.—The BOMBYCINA, including the *Citheroniidae, Hemileucidae, Saturniidae,* and *Bombycidae.*

IV.—The NOCTUINA, including the *Notodontidae, Thyatiridae, Geometridae, Drepanidae, Agaristidae, Noctuidae, Cymbidae, Lithosiidae, Pericopidae, Arctiidae, Euchromiidae, Lymantriidae,* and perhaps also the *Thyrididae, Dioptidae* and *Lasiocampidae.*

V.—The SPHINGINA, including the *Sphingidae.*

VI.—The RHOPALOCERA, including the families usually associated under this term.

---

* *American Naturalist,* 1895, p. 803.

† *Trans. Ent. Soc. Lond.,* 1896, pp. 129 *et seq.* and *Entom. Record,* vol. vii., pp., 268 *et seq.*

‡ "Relationship of Pyralidæ and Pterophoridæ from the larvæ," *Ent. News,* Feb., 1895.

There was sufficient material here for the basis on which to construct the broad lines of a natural genealogical tree, if used in conjunction with the tables given us by Chapman* and Hampson†. But the desiderated clue as to the actual details of such was not obtained until the publication of Chapman's valuable paper, "The phylogeny and evolution of the Lepidoptera from a pupal and oval standpoint." In this we had a factor that could be applied in the way desired, and that showed us, not which were specialised and which generalised superfamilies, but which of the specialised and which generalised superfamilies of the various stirpes were related to each other.

This paper showed that the form of egg found in each different superfamily is very constant, and that there appears to be no rapid transition from one form to the other among the Lepidoptera. There are, broadly, among the higher Obtect families, two forms of egg, the flat and the upright egg, the former being divisible into the Geometrid and the Bombycid. The Geometrid egg is generally marked by a greater roughness and by coarser ribbing or network; the Bombycid is smoother and more polished, although there are many striking exceptions to this otherwise pretty general rule. Chapman is inclined to derive these two forms of flat eggs from distinct origins, very low down in the evolutionary scale, but thinks it probable that the various forms of the upright egg (Noctuid, Papilionid, etc.) had a common origin, though very low down. He is supported in this conclusion by the presence of the chin-gland (*ante*, p. 94), which is found only in Papilionids, Noctuids, Notodonts and other superfamilies with upright eggs, but nowhere among those with flat eggs, and we may accept Chapman's conclusion that, however widely the butterflies are separated from the Noctuids, and the evidence of the Hesperid pupa shows that the butterfly stirps separated from the Noctuid stirps a very considerable way below any *Noctua*-like form usually placed with the Macros, the evidence of the egg and the presence of the larval chin-gland, suffice to show that they jointly separated from the Geometrids and Bombycids still lower down. The evidence of the egg, too, shows that the Noctuids and Papilionids were not derived, as Meyrick suggests, from any Pyralid form, as the Pyralids are, in some respects, of a higher type than the Hesperids, and yet the former still belong very markedly to one of the flat-egged stirpes. No very clear indication has yet been obtained to show where the upright egg branched from the flat egg. The most probable point is between the Cossids and Zeuzerids. These superfamilies are, in many respects, somewhat closely allied. The former has an upright, the latter a flat, egg, and Chapman considers that we have here, probably, the point where the two forms are still unfixed and capable of easy variation. The alliance (by pupa) of *Castnia* with *Cossus*, would perhaps point to this also as being somewhat near the origin of the butterfly stirps.

Accepting the principles here laid down, there can be no doubt that the flat egg is the ancestral form, and the upright egg a more specialised structure. Examination of a large number of eggs of species belonging to several superfamilies, shows that the upright eggs which characterise the Notodonts, Noctuids, Lithosiids, Euchromiids, Lymantriids and Papilionids, are modifications of one and the same structure.

---

* *Trans. Ent. Soc. Lond.*, 1893, pp. 118-119.

† *Annals and Magazine of Natural History*, 1894, pp. 258-259.

If now we turn back to Dyar's group IV, the NOCTUINA (*ante*, p. 107), and take the superfamilies with upright eggs therefrom, we have left a series of families of which the *Thyatiridae* (*Cymatophoridae*), *Geometridae* and *Drepanidae* are the most important. These show also a close alliance, not only *inter se*, but also with the Pyralids and Crambids, since they possess essentially the same type of egg.

Here, then, is clearly a dichotomous division in Dyar's NOCTUINA, one branch showing relationship with his MICRO-LEPIDOPTERA through the Cossids, the other through the Pyralids. Below these superfamilies (Cossids and Pyralids), however, the egg proves of very little value, but other characters of the larva, pupa, and imaginal neuration show that these MICRO-LEPIDOPTERA belong to one or other of the main stirpes above indicated. Dyar's NOCTUINA (specialised), and MICRO-LEPIDOPTERA (generalised), therefore, divide into the two following groups :—

I. The NOCTUO-HEPIALID STIRPS.—HEPIALIDES, ZEUZERIDES, TORTRICIDES, COSSIDES (generalised superfamilies), leading up to : (1) NOTODONTIDES, NOCTUIDES, NYCTEOLIDES, ARCTIIDES (with the Lithosiids), LYMANTRIIDES. (2) CASTNIIDES, HESPERIIDES, PAPILIONIDES (the specialised superfamilies).

II. The GEOMETRO-ERIOCRANIID STIRPS.—ERIOCRANIIDES, ADELIDES, TINEIDES, etc. (generalised superfamilies), leading up to BREPHIDES, CYMATOPHORIDES (THYATIRIDES), DREPANULIDES (PLATYPTERYGIDES), and GEOMETRIDES (the specialised superfamilies).

This arrangement practically absorbs three of Dyar's main divisions, leaving only the ANTHROCERINA, BOMBYCINA and SPHINGINA. It is very evident here, from an examination of the eggs, that these all belong to one stirps, and that Dyar has rightly diagnosed and divided these, his ANTHROCERINA representing the generalised, and his BOMBYCINA and SPHINGINA two specialised, branches of the same stirps. The latter works out thus :—

III.—The SPHINGO-MICROPTERYGID STIRPS.—MICROPTERYGIDES, NEPTICULIDES, EUCLEIDES, MEGALOPYGIDES, HETEROGYNIDES, ANTHROCERIDES, PSYCHIDES, PTEROPHORIDES (the generalised superfamilies), leading up to the LASIOCAMPIDES, EUPTEROTIDES, ENDROMIDES, BOMBYCIDES, SATURNIIDES and SPHINGIDES (the specialised superfamilies).

We are inclined to attach but little importance to the pre-spiracular tubercle of the Sphingids ; the whole of the other essential characters, both of egg and larva, showing considerable affinity with the Endromids and Saturniids.

One of the most puzzling points in the taxonomy of the Lepidoptera is the affinity of the Pterophorids. The imagines of this superfamily have, in common with the Orneodids (Alucitids), "plumed" wings, and therefore our more superficial investigators place them somewhere near each other. Of their utter want of relationship Chapman speaks with no uncertain sound. He says* : *Epermenia* and *Orneodes* are typical members of the Pyraloid-Micropterygid (*i.e.*, Pyraloid-Eriocraniid) series ; *Pterophorus* is not a member of this series, etc. Again, he notes† : There is no relationship between the pupa of *Orneodes* and that of *Pterophorus*. The latter has not followed the line towards the Macros that has been taken by the PYRALIDES, but has struck out an entirely separate line of its own, and still retains nearly all the features of a Micro pupa. The only point that interests us here, in connection with

---

* *Trans. Ent. Soc. Lond.*, 1896; p. 145.

† *Ent. Record*, vol. vii., No. 11, 1896.

Orneodes, is that the one Micro character which *Orneodes* has preserved and exaggerated (the large cephalic dorsal plate) happens, in *Pterophorus*, to have taken precisely the contrary direction. In *Pterophorus* it hardly exists, and is difficult to see; yet it does exist, and that so effectually that, as in nearly all Micros, it carries the eye-cover with it on dehiscence. Dyar is quite clear as to the larva, and associates the Pterophorids with the Anthrocerids, and as we have examined many of the larvæ of this superfamily, we can the more readily acquiesce in his claim for this alliance. The smooth Pterophorid egg, too, supports very strongly the suggested alliance with the Anthrocerids. Yet there are strange peculiarities about the Pterophorids as a member of this stirps, not the least of which is the development of a cremaster, by which it attaches itself after the fashion of *Hypercallia*, *Zonosoma*, and the Papilionid pupæ. By the development of this cremastral attachment, the Pterophorid pupa has lost the character of motility, practically universal among the superfamilies with Incomplete pupæ. On this account, Chapman considers that the Pterophorids are one of the highest of the superfamilies in the INCOMPLETÆ. On the other hand, the abdominal prolegs of the Anthrocerid larva are so completely of the typical Macro form, *i.e.*, have hooks only on the inner side of the foot, that this character places the latter superfamily also high among the INCOMPLETÆ. There is difficulty in detecting the eye-collar (which is remarkably well-developed in the lowest superfamilies of the Sphingo-Micropterygid stirps) in the Pterophorid, and, to a less extent, in the Anthrocerid, pupa, another character that places them moderately high in their stirps.

Chapman considers that, besides the Micropterygids and Eriocraniids, the Hepialids, Nepticulids, and possibly, even the Psychids, have been derived directly from the Palæo-lepidoptera, without any intermediate forms that we now possess to indicate the special lines they took, and that the lines of their evolution, therefore, diverged from this low point.

With regard to our distribution of the MICROPTERYGIDES, ERIOCRANIIDES and HEPIALIDES, as the bases of the Sphingo-Micropterygid, Geometro-Eriocraniid and Noctuo-Hepialid stirpes respectively, we may at once state that each of these might equally well be put at the bottom of any stirps. The Micropterygids are, presumably, the lowest form we have, and, therefore, might be placed as a base for all the stirpes. This superfamily and the Nepticulids, however, show more interesting parallels with the generalised superfamilies (Eucleids, etc.) of the Sphingo-Micropterygid stirps, than with those of any other, and hence are best treated here. Chapman has shown* clearly that the Eriocraniids have no very close alliance with the Micropterygids, but he also points† out that they show distinct relationship with the Adelids (by way of *Incurvaria*), and through them with the Tineids, Pyraloids and Pyralids. He further points out that the Hepialids, whilst preserving many Tineid characters, show distinct alliance with the Cossids, and that the latter have all the essential characters of the Tortricid, as distinguished from the Tineid, stirps. We have, therefore, selected those of these superfamilies nearest to the lower forms of each of our three stirpes, and propose to bring them into examination with the stirps to which they have been respectively attached.

---

* *Trans. Ent. Soc. Lond.*, 1894, pp. 336 *et seq.*

† *Ibid.*, 1896, p. 132.

The Micropterygids and Nepticulids, therefore, will be considered in connection with the Sphingo-Micropterygid group, although, as we have just shown, they might almost as well have been treated with all the lower superfamilies together. It is, however, necessary to break down the idea that there is a great hiatus between the lower (Incomplete) forms, and the higher (Obtect) forms on the same stirps, or a similar hiatus between the smaller species and the larger. For the same reason, although we place the Eriocraniids at the base of the Geometro-Eriocraniid stirps, they might equally well be placed almost at the bottom of all Lepidoptera. The Hepialids, owing to their relationship with the Zeuzerids and Cossids, are placed at the bottom of the Noctuo-Hepialid stirps.

There are one or two points in which we think the sum total of characters shows that Dyar and Hampson have erred in their groupings. Thus the PSYCHIDES belong rather to the Sphingo-Micropterygid than to the Geometro-Eriocraniid stirps. The LASIOCAMPIDES most distinctly belong to Dyar's BOMBYCINA, *i.e.*, to our Sphingo-Micropterygid stirps, whilst the NOTODONTIDES as certainly belong to the Noctuo-Hepialid stirps. We have already shown that Dyar's NOCTUINA is heterogeneous on the egg characters, and the two main branches included must be differentiated on other larval characters than those already used, so as to separate the true Noctuids from the Geometrids. We observe* that Hampson finds neurational characters to make this separation.

We are totally unable to accept the conclusions reached in Dyar's "Synopsis of the Families of Bombycides" (*Proc. Bos. Soc. of Nat. History*, vol. xxvii., pp. 129-130) as being of any real classificatory value. In this we find the *Notodontidae*, *Pseudoipsidae*, *Noctuidae*, *Apatelidae*, *Arctiidae*, *Pericopidae*, *Nolidae*, *Lithosiidae*, *Euchromiidae*, *Lymantriidae* (of the Noctuo-Hepialid stirps), *Brephidae*, *Geometridae*, *Thyatiridae* and *Drepanidae* (of the Geometro-Eriocraniid stirps), united with the *Bombycidae*, *Eupterotidae* and *Lasiocampidae* (of the Sphingo-Micropterygid stirps), to make up the "Higher Bombyces." To explain away the position of the Eupterotids, in which Dyar recognises that tubercles iv and v do not satisfy his definition of the group, we learn that "warts iv and v are degenerate, and have come to assume a generalised position, probably secondarily" (p. 128). Concerning the *Bombycidae*, Dyar states, what is a fact, that "the warts are small and degenerate, but they are true warts of the typical Lasiocampid pattern" (p. 140). Regarding the warts of the Lasiocampids, we read that "on the abdominal segments (of *Tolype velleda*), v is smaller than iv, and all except i and vi are greatly reduced. These two warts alone persist in the adult" (p. 144). The reduction of iv is quite characteristic of the higher branches of the Lasiocampids, Bombycids, Eupterotids, etc., and entirely different from the well-defined post-spiracular iv of the Noctuids, Arctiids, etc.

In its broadest lines, then, our scheme of classification assumes three main general evolutionary branches, along which the various superfamilies of Lepidoptera have developed, two of these being flat-egged and one an upright-egged stirps. These, with the main superfamilies included in each, have already been given (*ante*, p. 109), so that there is no need to repeat them.

---

* *Annals and Magazine of Natural History*, Oct., 1894, p. 259.

That the details of such an arrangement as this will be modified by further observation is highly probable, but that this will form a sound basis for future work we feel convinced. We shall find, for example, in future schemes, no derivation of generalised from specialised superfamilies, nor a flat-egged family from an upright-egged one, the former giving rise again to another upright-egged family, as repeatedly occurs in the work of Packard, Dyar and Meyrick. As an illustration of this point we may give the following: Packard derives *Lithosiidae* (an Arctiid form, with upright egg and Arctiid larva) from *Tineina* (with flat egg), and then derives the *Geometridae* (another flat-egged group) from the *Lithosiidae*. In his work* the following series occurs: *Tineina* (flat egg), *Notodontidae* (upright egg), *Ceratocampidae* (flat egg), etc., *i.e.*, a reversion from the "upright" to the "flat" egg form in every alternate stage of the evolution. Dyar, too, obtains the following series in one of his phylogenetic trees: Notodonts (upright egg), Eupterotids (flat egg), Lymantriids (upright), Bombycids and Lasiocampid (flat eggs), an impossible combination.

The diagram (Plate I) which we have added to illustrate this chapter will show roughly our views as to the evolution of the three main stirpes at their base, and the details of the evolution of the Sphingo-Micropterygid stirps.

---

* *American Naturalist*, 1895, p. 803.

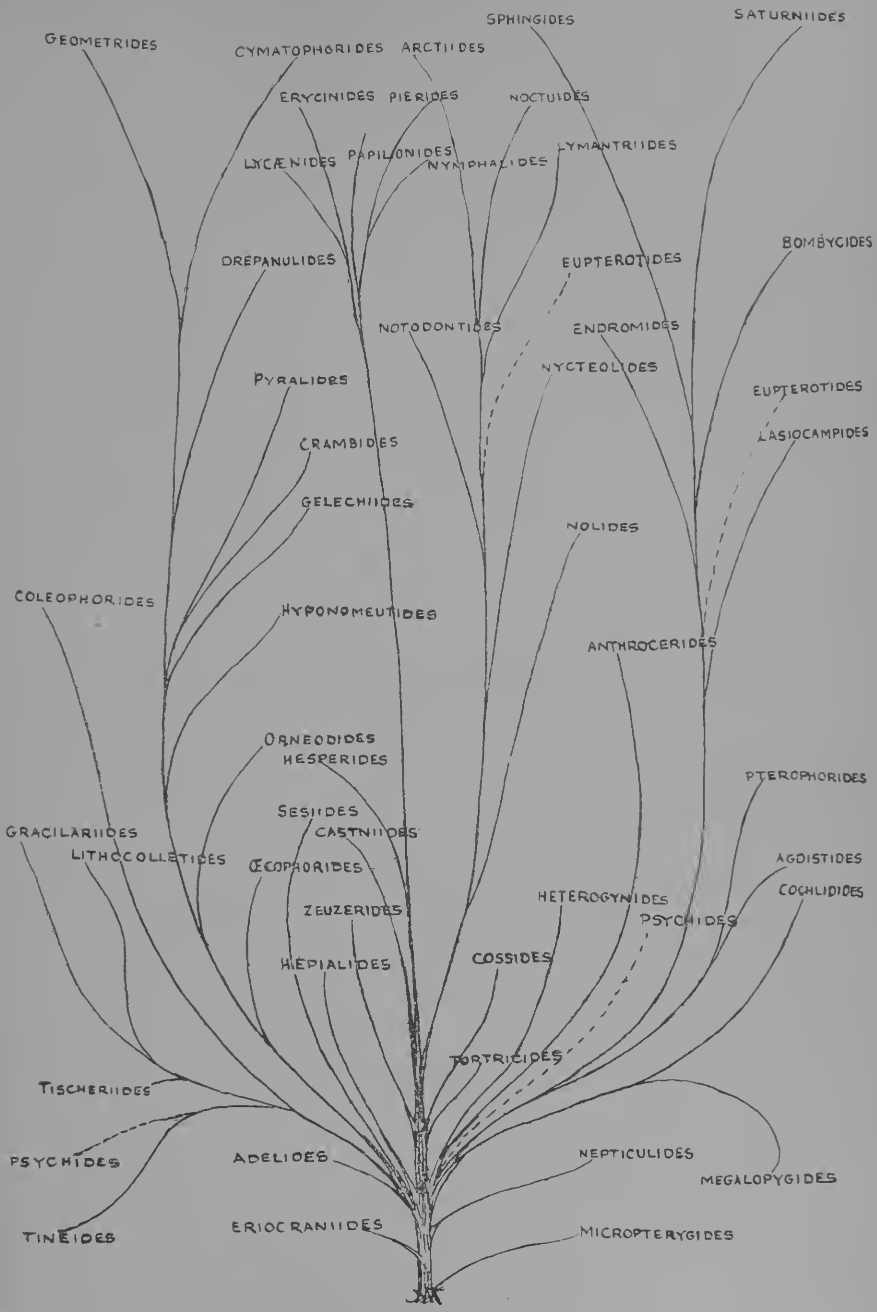

SPHINGIDES
SATURNIIDES
GEOMETRIDES
CYMATOPHORIDES
ARCTIIDES
ERYCINIDES
PIERIDES
NOCTUIDES
LYMANTRIIDES
LYCÆNIDES
PAPILIONIDES
NYMPHALIDES
BOMBYCIDES
DREPANULIDES
EUPTEROTIDES
NOTODONTIDES
ENDROMIDES
NYCTEOLIDES
PYRALIDES
EUPTEROTIDES
LASIOCAMPIDES
CRAMBIDES
GELECHIIDES
NOLIDES
COLEOPHORIDES
HYPONOMEUTIDES
ANTHROCERIDES
ORNEODIDES
HESPERIDES
PTEROPHORIDES
SESIIDES
CASTNIIDES
GRACILARIIDES
LITHOCOLLETIDES
ŒCOPHORIDES
AGDISTIDES
COCHLIDIDES
ZEUZERIDES
HETEROGYNIDES
PSYCHIDES
HEPIALIDES
COSSIDES
TORTRICIDES
TISCHERIIDES
PSYCHIDES
ADELIDES
NEPTICULIDES
MEGALOPYGIDES
TINEIDES
ERIOCRANIIDES
MICROPTERYGIDES

Plate I.

Phylogenetic tree illustrating the development of Lepidoptera from a hypothetical base.

THE SPHINGO-MICROPTERYGID STIRPS.

Stirps I: SPHINGO-MICROPTERYGIDES.

The Sphingo-Micropterygid (or as we have sometimes termed it, the Sphingo-Bombycid) stirps is so-called from two of the most characteristic superfamilies it contains, the Sphingides and the Micropterygides (Eriocephalids), the former, one of the most specialised, the latter, one of the most generalised, of the superfamilies, not only of the stirps, but of all Lepidoptera.

Although our knowledge is at present very incomplete, there appears to be good ground for including on the same evolutionary line with these superfamilies, several others of considerable size and importance. These are all more or less characterised by the following structural peculiarities:—

(1) The possession of a flat egg (*i.e.*, with the long micropylar axis horizontal, and with a short vertical axis).

(2) The maintenance of tubercles iv and v, as sub-spiracular tubercles (except in Sphingids, where v becomes pre-spiracular*); a tendency for iv and v to become united into a single sub-spiracular wart; a tendency for i to form a many-haired dorsal wart, and to form, with iii and iv + v, on either side, a transverse row of warts on each segment; ii tends very strongly (in some families) to become atrophied.

The Micropterygids (*i.e.*, the Eriocephalids of Chapman) are so remarkable, that they have been separated by Packard into a sub-order equal in value to all other Lepidoptera combined, and thus we get:—

Sub-order I: LEPIDOPTERA-LACINIATA—including only the Micropterygides.

Sub-order II: LEPIDOPTERA-HAUSTELLATA:—
1. Palæo-lepidoptera (Pupæ-liberæ) including only Eriocranides.
2. Neo-lepidoptera (Pupæ-incompletæ, and Pupæ-obtectæ) including all other Lepidoptera.

This, however, represents only the separation of what we may call the stranded remnants of the ancestral lepidopterous fauna, and since Chapman remarks† that "the *Zygaenidae* (*Anthroceridae*), *Limacodidae* (*Eucleidae*), and *Micropterygidae* (*Eriocephalidae*) form a group which, though the last member is as low as the lowest *Tineina* and the first as high as the butterflies or Noctuids, has, nevertheless, been evolved on its own lines, from a common source, as a separate branch of Heterocera," we feel quite justified, in spite of the vast gulf that separates them, in retaining these as superfamilies of this stirps, for there are, of course, almost inconceivable breaks between the superfamilies, even of the same stirps, represented (1) in time, by æons of years, and (2) in evolutionary development, by the extinction of thousands of connecting groups, which once surrounded the existent groups, and of which we have now no trace, and can only vaguely surmise either their character or relationships.

Roughly, then, and bearing in mind what has just been said, we may divide the superfamilies of this stirps‡ into two groups according to the amount of specialisation they have undergone. We should then get:—

---

* In *Agdistis* iv becomes post-spiracular, and v sub-spiracular, thus differing from any other Plume larvæ known to us.

† *Trans. Ent. Soc. Lond.*, 1894, pp. 335 *et seq.*

‡ We are well aware that many other exotic superfamilies may belong to this stirps, but having no special knowledge of the early stages of the species of such superfamilies, they have been excluded.

I. GENERALISED SPHINGO - MICROPTERYGIDES.—Micropterygides, Nepticulides, Eucleides, Megalopygides, Heterogynides, Anthrocerides, Psychides and Pterophorides.

II. SPECIALISED SPHINGO - MICROPTERYGIDES. — Lasiocampides, Eupterotides, Endromides, Bombycides, Saturniides and Sphingides.

Some of these superfamilies are well-defined, but others have not yet been very clearly separated (by our authorities) from the superfamilies of the other stirpes that have undergone parallel development in the imaginal condition. The most important fact to bear in mind when considering the affinities of the generalised groups, is that the species of some of the superfamilies are more specialised (or at least more modified) in one stage than in the others, thus the Eucleids have a somewhat specialised larva, and yet the pupa is among the most generalised (with that of the Nepticulids) of all Lepidoptera, and we have just seen that the more or less generalised Anthrocerides are considered, by Chapman, to be, in some respects, as high as Papilionids or Noctuids. The Megalopygides are mainly separated from the Eucleides, owing to the presence of seven pairs of abdominal prolegs (on the 2nd-7th and 10th abdominal segments). The Eupterotides may be Lasiocampids, in the broadest sense, but are here restricted to the "processionary" moths, *Cnethocampa* and its allies. The Bombycides, similarly, are restricted to the group of which *Bombyx mori* is the type, and do not include the Endromides, as suggested by Kirby, nor do they include the Notodonts, Noctuids, and other superfamilies belonging to a quite distinct stirps, as recently insisted upon by Dyar and Grote. There is a tendency to split the Psychides into Tineid and Bombycid portions, but at present we have no information supporting this view.

With regard to the larvæ of this stirps, it may be worth while to recall attention here to a character that appears to be of some structural importance. In almost all larvæ belonging to the generalised superfamilies of the Lepidoptera, tubercles iv and v are normally placed below the spiracles, *i.e.*, both are sub-spiracular. In this stirps, the larvæ of the generalised superfamilies follow the usual formula in this respect, but there is a strong general tendency for tubercles iv and v to approximate, and (especially after the first moult) to form a many-haired wart, a character that is carried on also to many of the specialised superfamilies. Nor, in those superfamilies (Lasiocampides, etc.), in which there is a distinct tendency to the obliteration of the warts, owing to the development of a hairy coat from the ordinary pile of the body, does iv move up to form a distinctly post-spiracular tubercle, a line of evolution very general in the Noctuo-Hepialid stirps, and probably also in the Geometro-Eriocraniid. On the other hand, this movement is said to take place in *Agdistis*, at present classified with the Pterophorides.

The diagramatic representation (Pl. I) will illustrate roughly what we consider the probable lines of development taken by this stirps, and its connection with the other stirpes. It will be noticed that we have attempted to avoid the method of deriving one superfamily from an existent superfamily. The main line, we consider, carries on many of the ancestral features of egg, larva, pupa and imago, some, maybe, not much modified, whilst others are exceedingly modified. Many characters have, of course, been entirely lost. From this main stem, each branch has carried on certain broad characters, which have become modified into those more special characters which mark the superfamily. The break between the generalised and specialised superfamilies of the stirps is a very great one, and the reason thereof is not difficult to understand: (1) Larvæ are specialised for protective and defensive purposes in such a manner as to obscure the primary structural characters. (2) The obtect pupa (which characterises the specialised superfamilies, not only of this but also of each of the other stirpes) is very similar throughout all the Lepidoptera, the ancestral traces have largely disappeared and structural characters are very uniform. (3) In the imago, the neuration is largely modified by the peculiar structure and particular flying habits of each superfamily. In all stages, of course, secondary characters are at the mercy of the environment.

The relationship of the Micropterygids (Eriocephalids) to this stirps is worked[*] out at length by Chapman. He bases his conclusions on the pupal structure, the slug-like form and habit of external feeding of the larva, the homology existing between the extra abdominal prolegs and those of the Megalopygids, and between the latter and the abdominal suckers of the Eucleids; the parallelism between the disposition and structure of the spines of the newly-hatched Eucleid larva, *Apoda avellana* (*testudo*), with the similar arrangement in the larva of the Micropterygids. With regard to this latter point, Chapman says: The spines of the newly-hatched larva of *Apoda avellana* (*testudo*) are parallel in disposition and structure with nothing known, except the similar arrangements in *Micropteryx* (*Eriocephala*).

The relationship of the Nepticulids with the Eucleids is also dealt[†] with at length by Chapman. He finds the eggs very similar, an agreement in the apodous condition of their larvæ (although it must not be forgotten that the former is a miner), and a similarity amounting almost to identity in the pupæ, both superfamilies presenting the incomplete pupa in its most extreme form, the segments and appendages being quite free in both of them. This latter factor appears to suggest that our treatment of MICROPTERYGIDES, as a superfamily of this stirps, is preferable to that of Packard, whose definition of "Pupæ-liberæ" is evidently applicable to other pupæ, besides those of the Micropterygids.

The generalised superfamilies of this stirps (excluding the Nepticulids) form Dyar's ANTHROCERINA, which he characterises[‡] from the larval characters as follows:

Tubercles with single seta, or converted into warts, or absent; i and ii, as well as iv and v, approximate or consolidated. Includes the families, *Pterophoridae*, *Anthroceridae* (and *Pyromorphidae*), *Megalopygidae* and *Eucleidae*.

I.—Body cylindrical, prolegs normal, setæ single or converted into warts ... ... *Pterophoridae.*
II.—Body more or less flattened ventrally.
  1.—Tubercles converted into warts; iv and v distinct.[§]
    a.—Prolegs normal; warts reduced ... *Anthroceridae.*
    b.—Two additional pairs of prolegs without hooks; warts hairy ... ... *Megalopygidae.*
  2.—Tubercles converted into spinous processes or absent; iv and v aborted; abdominal prolegs replaced by sticky ventral surface ... ... *Eucleidae.*

---

[*] *Trans. Ent. Soc. Lond.*, 1894, pp, 335 *et seq.*

[†] *Trans. Ent. Soc. Lond.*, 1893, pp. 115 *et seq.*

[‡] Additional notes on the Classification of Lepidopterous Larvæ," *Trans. New York Acad. Sci.*, vol. xiv., 1895. p. 54.

[§] We would here observe that after the first skin iv and v are as much consolidated as i and ii in *Anthrocera*.

We are unable to accept Dyar's distinction of "Body cylindrical" for the *Pterophoridae* and "Body more or less flattened ventrally" for the *Anthroceridae*, as being of real value, for such larvæ as those of *Aciptilia galactodactyla*, *A. spilodactyla*, etc., are most distinctly flattened ventrally. There is also considerable variation in the character of the Pterophorid prolegs, and also in the character of their warts. Our own summary of these related generalised superfamilies based on Dyar's lines would rather be:—

I.—Body cylindrical; case-bearers; third pair of true legs enlarged; tubercles with simple seta, and very small; tubercles i, ii and iii, often in an almost direct line above spiracle; iv and v approximate	PSYCHIDES.
II.—Body more or less flattened ventrally; prolegs, variable; tubercles, rarely with single seta, former usually converted into warts; iv and v usually approximate (except ? *Agdistis*).	
1.—With tubercles i and ii more or less separated; tubercles with simple seta, or changed into warts; prolegs, variable (from few hooks to almost full circle)...	PTEROPHORIDES.
2.—With highly specialised prolegs.	
a.—Tubercles forming many-haired warts; i and ii united into large wart, also iv and v.	ANTHROCERIDES.
b.—Tubercles simple, with single seta ...	HETEROGYNIDES.
3.—With prolegs modified.	
a.—Seven pairs of abnormal prolegs, 5 pairs normal, with usual hooks, those on abdominal segments 2 and 7 without hooks; warts hairy	MEGALOPYGIDES.
b.—Prolegs forming sticky sucking-discs on abdominal segments 2—7; tubercles converted into spinous processes, or absent; iv and v aborted	EUCLEIDES.

In many respects the HETEROGYNIDES, a superfamily not included in this tabulation by Dyar, shows very strong Anthrocerid affinities. It has a somewhat Anthrocerid-looking egg, but the eggs are laid within the pupa-case (a common Psychid habit). The wingless female, by a vermiform movement, re-enters the pupa-case after fertilisation; the apterous condition of the female is another Psychid affinity; but the larva and pupa are distinctly Anthrocerid, although the tubercles bear a single seta, and tubercles iv and v are distinct, and not warted as in *Anthrocera*; the male is very like a Procrid, with some suspicion of a Psychid; the soft, fluffy, silken cocoon being quite *sui generis*, yet approaching *Anthrocera*. Dyar suggests* for *Heterogyna* an affinity with COSSINA (Adelids, Psychids, Cossids, Pyralids, Tortricids, Sesiids, Tineids, Orneodids and Lacosomids), but this must not be taken too seriously, for, later in the same paper (p. 25), the author defines the COSSINA in terms so general, that it absorbs the ANTHROCERINA (Eucleids, Megalopygids, Anthrocerids and Pterophorids), and the term (COSSINA) becomes merely a name, in which the generalised families of all the different stirpes are included. Chapman says that, among the Anthrocerids, he has failed to detect any structures in the young larvæ examined at all parallel with the spines of *Apoda avellana*, and must still rely on the structure of the egg, the form and habit of the larva, and the very primitive form of the pupa for its alliance with this section (*Trans. Ent. Soc. Lond.*, 1894, p. 348).

---

* "Combination of two classifications of Lepidoptera," *Journal New York Ent. Soc.*, 1895, p. 20.

The Psychids have been spoken of recently by authors as if they were Tineids of the very lowest type. This is not so. They form a generalised superfamily, but not only is the larva of a rather high type (for a generalised group), the pupa also has advanced much more than has that of *Anthrocera* since they separated from the main stem. Although we consider that the common features of the Anthrocerids and Psychids were not derived the one from the other, but were obtained from a common ancestor remote from both, yet, taking into account the respective specialisation of the two superfamilies, it is evident that such points of resemblance as exist in Heterogynids and Psychids have been derived by the latter from the former, rather than *vice versâ*.

The Pterophorids, as Chapman has proved*, have no alliance structurally with the Orneodids (Alucitids) and Pyralids, with which they have been associated, and Dyar and others have shown their alliance with the Anthrocerid stirps. Their larvæ exhibit a very wide range of variation, some possessing quite simple tubercles, with a single seta, and having tubercles, i, ii and iii, arranged above each other, and above the spiracle, almost exactly as in certain Psychids. Others have the tubercles converted into many-haired warts, very similar to those of Anthrocerid larvæ; in many, i and ii are united into a large many-haired wart, iii forming a second, and iv and v a third, similar wart, thus forming on each segment a ring of prominent hairy warts, so characteristic of this stirps. One genus, *Agdistis*, has tubercles bearing a simple seta on all the abdominal segments except the 9th, on which there is a caudal horn, reminding one of the Sphingids. This genus, too, is said to have iv and v developed as post- and sub-spiracular tubercles respectively, a most aberrant condition, if true, for this stirps. That the Pterophorids thus show, *inter se*, a wide range of larval characters is evident. Some of these characters, too, are largely correlated with the habits and mode of life of the larvæ, those with simple tubercles being borers. The near approach of the larvæ which bear many-haired warts, in their habits and structure, to those of the Anthrocerids is very marked. It must be admitted, in spite of this, that the affinities of the Pterophorids are more puzzling than those of any other of the generalised superfamilies of the stirps. The pupal attachment by a cremaster, in this group, is also remarkable.

The difficulty of placing the Pterophorids at all satisfactorily is, perhaps, sufficient warrant for following Chapman and Dyar in this respect. The former concludes that they might be placed with his Micros whose larvæ are exposed feeders. He says†: Dyar places these with the Anthrocerids and Limacodids, and, both in structure and habits, the larva falls into that division as readily as into any other; at any rate, it is almost certainly not a member of the Adelid series. Further, Chapman states that there is extreme divergence between the pupa of Pterophorids and that of Pyralids, the latter having a pupa that is a true Macro in dehiscence, with the 4th and 7th abdominal segments fixed in both sexes and possessing no Micro characters, except a dorsal headpiece (a character that goes very high up), maxillary palpi, and,

---

* *Trans. Ent. Soc. Lond.*, 1896, pp. 129 *et seq.*

† "Notes on Pupæ," etc., *Trans. Ent. Soc. Lond.*, 1896, pp. 136-137.

in some families, appendages that project beyond the 4th abdominal segment. The Pterophorid pupa is a true Micro in dehiscence, has the 4th abdominal segment free in both sexes (and the 7th also in the male), the dorsal headpiece is evanescent, and it has lost the maxillary palpi. As Chapman concludes that "it is impossible for one of these forms to be derived from the other," we consider ourselves quite justified in following Dyar, and linking the Pterophorids with the lower superfamilies of the stirps under consideration.

Having briefly discussed the general relationship of the lower superfamilies of this stirps to each other, it may now be of advantage to examine, in more detail, the characters offered by the egg, larva and pupa.

The Sphingo-Micropterygid stirps, we have already stated, is characterised by the possession of a flat egg, *i.e.*, an egg with the micropyle at the end of the long, horizontal axis. The egg has three axes of different lengths, of which the micropylar is the longest, and the vertical the shortest. The surface is generally smooth, the sculpturing very slight and shallow, the shell thin, the texture tending to be delicate, and it has both ends of pretty equal size, not being more narrowed towards the micropylar than it is at the opposite end. The Anthrocerid, Pterophorid, and Sphingid eggs, are, however, much more delicate than those of the Lasiocampid and allied branches of the stirps. Although the Eucleid egg is hardly typical for this group, being soft, scale-like, and somewhat flattened, and, in these respects, resembling closely the Tortricid egg, Chapman says that "the type of egg described above, as characteristic of the Sphingo-Micropterygid stirps, is so similar to that obtaining in the Anthrocerids (Zygænids) and Megalopygids (Cochliopodids), that the assumption may be made that the stirps originated in these families."

The egg of the *Megalopygidae* (*teste* Packard) does not appear to us to be so different from what one might have supposed to belong to the most generalised form of this stirps. As represented by *Lagoa crispata*, the micropylar length : the other horizontal diameter : : 3½ : 1, the height is, however, reduced to the least possible dimensions. Still, it is essentially a flat egg in all its characters, with three unequal axes; of which the one representing the thickness is the least. We have, elsewhere, remarked on its similarity to the Anthrocerid egg, and on its being covered with silky hairs, as in some Lasiocampids—*Trichiura crataegi*, *Eriogaster lanestris*, etc.

There is no typical larva for this stirps, that of every superfamily having been specialised (or modified) in its own particular direction. The Micropterygid larva (like the egg) is quite *sui generis*, but exhibits, as already detailed, some remarkable parallels with that of the Eucleids. The Nepticulid larva, feeding on the parenchyma of the leaves, is a mining whitish-coloured grub, with nine pairs of hookless discs on the abdominal segments. The Eucleid (Cochliopodid) larva has been specialised in many ways, the most remarkable of which is, however, in the substitution of crawling discs for prolegs. The Anthrocerid and some Pterophorid larvæ have been specialised in the union of tubercles i+ii and iv+v into large hair-bearing warts similar to iii, so that there are three large warts on either side of each segment. The *Agdistis* larva is further specialised by the development of a caudal horn on abdominal segment 9 (not 8, as in the Sphingids).

The Lasiocampid larva, in many ways generalised, is specialised in the direction of a thick hairy coat developed from the secondary or skin (not tubercular) hairs, whilst the normal tubercles have become much atrophied or flattened, although their position is similar to that found in the more generalised superfamilies. The Bombycid and Eupterotid larvæ show affinities tending to lessen the distance between the Lasiocampids and Sphingids, the former inclining to the Sphingids, the latter to the Lasiocampids. The Endromid larva is remarkable for its general Lasiocampid structure (warts, etc.) in the 1st skin, and general Sphingid appearance in the later skins, whilst the Sphingids and Saturniids present to us some of the most highly specialised of lepidopterous larvæ; the former with its bright, oblique, lateral stripes, and prominent caudal horn, the latter, with its remarkable spines and hairs presenting to us larval types that have lost almost all traces of the general characters that distinguish the least modified superfamilies. Chapman states that larvæ have not yet been found, that present characters to bridge over the distance between the Cochliopodids and Lasiocampids, but Packard hints that the Megalopygid larva (*Lagoa*) is connected with the Saturniids. The observations, however, made by Chapman on the spines of the larva of *Apoda* and *Eacles*, as well as on those of Sphingids and Saturniids, tend to show that all are branches of the same stirps. The observations of Poulton and Weismann on the larvæ of *Aglia* and other Saturniids, and the comparison of these with the Sphingid larvæ, leave little room for doubt that these superfamilies are somewhat closely related. Packard's studies also indicate that similar relationships exist, and he also is able to show considerable agreement between the larvæ of the Ceratocampids and the Sphingids.

It may now be advisable to consider the larvæ of some of the superfamilies at greater length. In the larvæ of the generalised members of this stirps, specialisation (following the living of an exposed life) takes place in different ways: (1) By the conversion of a simple tubercle into a raised wart, the latter bearing many setæ, resulting in a hairy armature. (2) The reduction of the normal tubercles and specialisation of colour for protective purposes. As to the reduction of the tubercles, Dyar says*: "This condition is to be seen in the Pterophorids, where tubercle i has disappeared. Then there is the reduction and disappearance of the subventral tubercles, leaving but two above the spiracle and one below. This is probably in adaptation to the form of the larva which is now becoming flattened with shortening of the prolegs. The Pyromorphids and Megalopygids are in this condition. Following this, the sub-stigmatal tubercles iv and v disappear, and the flattening of the ventral region reaches its extreme. The hairs of the tubercles have also been gradually converted into stinging (? urticating) spines. In the Megalopygids, they are only partially converted; but in the Eucleids, the conversion is complete, and we have, finally, the highest type of the Micro-lepidoptera (generalised), and, perhaps, the most highly modified of all Lepidoptera. It is interesting to note that the Eucleid moths are much more generalised than those of several of the families which precede them, while the larvæ are so highly specialised. This illustrates the principle that specialisation in the larva may be accompanied by a generalisation of the moth." It is notorious, Dyar adds, that the Eucleid larvæ live for an unusually long period.

---

* "Classification of Lepidopterous Larvæ," *Ann. New York Acad. Sci.*, viii., p. 206.

The Megalopygid larva has the arrangement of the tubercles the same as in the Pyromorphid (*i.e.*, Anthrocerid). It also has two additional pairs of prolegs, *viz.*, those on the 2nd and 7th abdominal segments (paralleled only perhaps by traces of extra pairs in *Pselnophorus brachydactylus* on the 1st and 2nd abdominal segments). These two additional pairs were carefully figured and described (*Surinamsche Vlinders*, I., pl. xiv., and explanation) by Sepp. With Packard's conclusion "that this larva represents, as no other known caterpillar the polypodous ancestor of all Lepidoptera," we are quite unable to agree, since, in our opinion, the abdominal prolegs are quite secondary structures. The condition of the rudimentary prolegs on the 2nd and 7th abdominal segments shows, we think, the manner in which the sucking discs of the Eucleid larvæ have been developed, and how the latter have obtained their peculiar mode of progression.

As we have already pointed out, the range of larval characters in the Pterophorids is a wide one, and shows how modification may be brought about in an otherwise closely related superfamily. In the miners, the tubercles bear single setæ, and are degenerate. In others, the tubercles are modified into warts that are largely characteristic of the generalised superfamilies of this stirps. In *Aglistis*, the dorsal tubercles of the 9th abdominal segment are modified into a caudal horn. Dyar, speaking of the relationship of the Anthrocerid and Pterophorid larvæ, says*: "The Anthrocerid larva, *A. filipendulae*, has the tubercles converted into warts, but the warts are greatly reduced, being represented by tufts of short hairs. Tubercle i† is absent, iv and v are consolidated, and vii is very distinct on the base of the leg." Here, Dyar says, we have direct evidence of the continuity of this series of families with the ancestors of the Pterophorids and their allies. Further, Dyar states that the Pyromorphids (Anthrocerids) show essentially the same structure as the Megalopygid and Eucleid larvæ, but there are no urticating spines, and the prolegs are normal.

There are two distinct lines in which specialisation of the tubercles of the larvæ of this stirps, produces a very similar result, although the essential characters of the development are very different. Thus specialisation here takes place in the reduction of the number of tubercles, and this may occur: (1) By the union of two or more primitive tubercles, as in the union of iv and v to form a single subspiracular wart in the Anthrocerids. (2) By actual disappearance of the tubercles as in some Eucleids, Bombycids, Saturniids, etc.‡ It is quite clear that it is possible, therefore, to have a similar general result arrived at by two entirely different processes of evolution, and to have two superficially similar types having no real phylogenetic relationship. It is, therefore, important to compare the results obtained from the imago, pupa and egg with those obtained from the larva, otherwise, one may readily fall into error. Thus the actual relationships and position of the generalised members of this stirps, the Anthrocerids (including the Pyromorphids), the Eucleids and the Megalopygids, are very doubtful if the characters of the larvæ alone be considered.

---

* "Classification of Lepidopterous Larvæ," *Ann. New York Acad. Sci.*, viii., p. 211.

† On the contrary, tubercle i is coalesced with ii, forming a large dorsal wart, in which there is a distinct trace of the two separate portions of which it is formed. See our description of this and the allied larvæ, later in this book.

‡ There is a tendency, in Lasiocampid, Bombycid, and Saturniid larvæ, very slight in some species, but very strong in others, for tubercle i to become greatly enlarged and specialised, and for ii to become atrophied. In the early stages of *Saturnia pavonia* and *Bombyx mori*, ii exists as a minute tubercle with (or without) a single seta, whilst i is large and many-haired. At a subsequent moult ii is lost by atrophy, it does not merge into i.

We have already dealt with the relationships exhibited by the generalised superfamilies of this group, and we have already pointed out, that one of the most important larval characters in them is the union of tubercles iv and v into a large sub-spiracular, many-haired wart, after the first larval stage. Dyar notices that this generalised character is also found in otherwise highly specialised Saturniids, and is strongly suggestive of the alliance of the Saturniids with this group. The Lasiocampid and Bombycid larvæ also show many characters that ally them with the more generalised superfamilies of the stirps, although in the former the development of a hairy coat has led to the obliteration of the tubercles, iv being, indeed, almost obsolete. There seems to be but little difference between the urticating spines of the hairy Eucleids and those of the Lasiocampids, Packard stating that those of *Empretia stimulea* are only loosely attached, as is the case with those of *Lasiocampa quercûs* and *Macrothylacia rubi*, and we look upon the Lasiocampids as the most nearly allied of the specialised families of this stirps, to the generalised Eucleids and Megalopygids. The break between the Lasiocampids and Megalopygids is, however, a very wide one. On the other hand, we understand that the Megalopygid egg is very like the Anthrocerid (not so scale-like as the Eucleid) egg; but, in spite of this, the Megalopygids are still closer to the Eucleids than to the Anthrocerids, the generalised pupæ and the neuration being very similar, and so far as the larvæ are concerned we are inclined to look upon the creeping discs of the Eucleid larva as exhibiting a specialised form derived from the extra prolegged Megalopygid larva, for, in the latter, the abdominal segments 2 and 7 bear extra prolegs without hooks, and are not very dissimilar from what might be assumed as a first stage in the development of the Eucleid suckers. At any rate, so close is the alliance, and so far back in the evolutionary period are the Eucleids, that at the time of their origin there must have been great plasticity as to prolegs, and the specialisation is not difficult to understand. The entire absence of armature in the highest Eucleid larvæ tends to show that the Eucleid larva is essentially a specialised form of the hairy Megalopygid. It is, therefore, from an ancestor resembling the former rather than the latter, that we are inclined to derive the Lasiocampids, and we find that the latter have retained certain generalised characters exhibited by the former, of which the habit of covering the eggs with silken hairs, the possession of specialised, urticating, larval hairs, the peculiar "eggar" cocoon, with its separately formed lid, the thin transparent pupal integument, and the pectinated antennæ of the imago are still common to both.* For these reasons we are inclined to look upon the Lasiocampid ancestor as resembling the pro-legged Megalopygid, rather than, in this particular, the more specialised Eucleid stock.

---

* Some of these peculiarities are, we know, to be found in species belonging to other stirpes, and it is quite possible that some of them, at least, were derived from an ancestor even older than the Megalopygid, from which both the Megalopygids and the Liparids obtained their special peculiarities in this direction.

We have already referred to Dyar's statement that the Saturniid larva, by the union of tubercles iv and v into a sub-spiracular wart, resembles the generalised members of this stirps. Packard says that the larva of the Megalopygid, *Lagoa crispata*, is, in some respects, intermediate between the *Saturniidae* (especially the higher *Attacinae*) and the *Cochliopodidae* (*Eucleidae*). The characters of the clypeus, the setiferous tubercles, the distinct separation of the segments from each other (*i.e.*, the well-marked segmental incisions) are the points, Packard says, in which the larva of *Lagoa* approach the *Attacinae* (*Proc. Amer. Phil. Soc.*, xxxii., p. 292). He further states (*Ibid.*, 1893, p. 83) that the shape of the young larvæ of *Adoneta* and *Empretia*, with their large tubercles bearing three radiating setæ or bristles, is such as to remind one of the larvæ of the *Saturniidae*, and to suggest one of two alternatives: (1) The Cochliopodids (Megalopygids and Eucleids) have originated from the Saturniids, or from forms allied to them. (2) Both the Saturniids and Cochliopodids have descended from a common stem form. The first alternative of deriving a generalised from a specialised superfamily is out of the question. With the second, of course, we agree, since we are treating them as members of the same stirps.

Packard further draws attention to the fact that in some of the Saturniids the setæ are modified into urticating spines, as in the Eucleids. This similarity, Dyar considers,* does not imply relationship since there is here only a similarity of function, whilst the structure of the bases of the tubercles is essentially different. It is somewhat remarkable also that in the Anthrocerids and Saturniids there is a tendency for the tubercles to be arranged in a single transverse line on each segment. In Anthrocerid larvæ, tubercles i and ii coalesce; in those of the Saturniids, Dyar says that ii disappears after the first moult, both developments (very different in actual value) ending in the same result, the production of a single wart in the place of i and ii. In both superfamilies iv and v are consolidated into a single wart.

Another superfamily that has been placed in this stirps is the LACOSOMIDES. It was grouped by Comstock with the SATURNIIDES, but Dyar says that it belongs to the generalised Frenatæ, and remarks† that the Lacosomid larvæ have retained a generalised condition on account of their secluded life . . . . and present a case the converse of that of the Eucleids, where specialisation has taken place in the larva and where the generalised adult gives the best indication of the relationship of these curious insects. He states‡ later, that the Lacosomids are in the same line of descent with the Saturniids. This superfamily, therefore, probably belongs to the stirps under consideration.

The EUPTEROTIDES, which Hampson first separated from the Notodonts, are very closely allied to the Lasiocampids. Their larvæ show the generalised condition of tubercles iv and v, both being sub-spiracular and ill-developed. They show no tendency to the conversion of iv into a post-spiracular wart, a characteristic feature of the stirps to which the Noctuids and Notodonts belong. The other characters of this stirps, *viz.*, the approximation of tubercles iv and v, and of i and ii, are, in those larvæ that have these tubercles best developed, well exhibited. The Lasiocampid larva agrees with the Eupterotid in the above characters, tubercle iv, too, being, in both, larger than v, although the absorption of the warts has gone on farther in the latter than in the former. The gregarious habits of our European species, *Cnethocampa processionea*, *C. pityocampa*, etc., are very similar to those presented by *Eriogaster* and *Clisiocampa*. The egg and pupa also suggest this as their correct position.

---

* "Classification of certain Lepidopterous Larvæ," *Ann. New. York. Acad. Sci.*, viii., p. 201.

† "Classification of Lepidopterous Larvæ," *Ann. New York Acad. Sci.*, viii., p. 202.

‡ "Classification of Lepidopterous Larvæ," *Trans. New York Acad. Sci.*, xiv., p. 51.

It is now generally conceded that the Endromid larva shows traces of Lasiocampid, Saturniid and Sphingid relationship, and this is borne out by the characters of the egg, pupa and imago. Kirby unites the Endromids with the BOMBYCIDES, and simply gives *Endromis* generic value in the latter superfamily. The Endromid and Sphingid larvæ tend to specialisation[*] of the tubercles by atrophy, as in the Lasiocampids. The newly-hatched larvæ of some species of the latter, show that the usual tubercles (many-haired warts) are present, even when they are not traceable in the later skins. This atrophy of the tubercles is accompanied by a specialisation (1) in the development of secondary hairs in the Lasiocampids, (2) in the development of protective coloration in the Endromids and Sphingids. The general texture and aspect of the larva and pupa of *Endromis* are Citheroniid; a pupa of *Endromis versicolor* is not at all unlike that of *Citheronia imperialis*, or of some of the African species that pupate underground. It is difficult, however, once full obtect rank has been attained, to find good structural characters for differentiation, the latter are so very uniform. The larva of *Endromis* is, in some respects, more generalised than that of most of the Saturniids, and whilst Poulton claims that the Sphingids have been derived from the Saturniids, through the *Ceratocampidae*, Packard believes that they came from a form more nearly resembling the Endromid larva. Packard is inclined to think that all the Bombycids, except the Arctians and Lithosians (which most certainly are not Bombycids, and do not belong to the same stirps as the latter) may have been evolved before the Sphingids appeared. This would make the latter the most recently evolved superfamily of this stirps, and as Packard says that the characters of the head, antennæ, thorax, and neuration separate widely the Sphingids and *Ceratocampidae* (*Citheroniidae*), it is practically certain that the origin of the former from Ceratocampid ancestors must have been remote, and that numbers of forms that originally connected them must now be extinct. Poulton claims[†] that by means of various tropical larvæ, intermediate in some characters between the Ceratocampid and Smerinthid larvæ, the Sphingids are to be derived from the Ceratocampids. He attempts to show that certain Sphingid larvæ, *Ceratomia quadricornis* from N. America, and *Lophostethus dumolinii* from Africa, combine the

---

[*] In the Sphingid larvæ, the tubercles are single-haired and small, and gradually become atrophied (or may be traceable) until the last stage. In *Endromis* the tubercles are many-haired warts, as in the Lasiocampids, and they are lost (except the lateral thoracic tubercles) at the first moult, and are replaced by shagreen tubercles.

[†] *Trans. Ent. Soc. Lond.*, 1888, pp. 568 *et seq.*

Saturniid and Smerinthid characters. Even Packard recognises[*] in his account of the larva of *Sphingicampa bicolor*, the probable soundness of Poulton's views, for he says of the larva of this species: "It is the most Sphinx-like of any Ceratocampid (or other Bombycid) larva I know, resembling Sphingid caterpillars in the following characters:—

1.—The shape of the head and its markings.
2.—The four thoracic horns like those of *Ceratomia*, perhaps a case of reversion in the latter.
3.—The caudal horn.
4.—The large, square, heavy anal legs.
5.—The skin granulated with small white tubercles.

One can, when we take into account the larvæ alone, well imagine that the Sphingids are, as claimed by Poulton, descended from the *Ceratocampidae*, though these may be only adaptive characters, and not applicable to the imagines, which differ in neuration, in the tongue, and in the proportion of the head-pieces." The characters furnished by the eggs and pupæ strongly support those obtained from the larva, and the modification of the tongue, so strongly developed in some Sphingids (*e.g.*, *Sphinx*), varies much within the superfamily itself, *e.g.*, compare *Smerinthus populi* with *Sphinx convolvuli*. The evolution of the tongue in *Sphinx*, and the higher Sphingid genera, is, nevertheless, very difficult of explanation in a stirps in which all (?) the superfamilies are characterised by weak or aborted tongues, and where this feature is even carried into the superfamily SPHINGIDES itself. Even the Anthrocerids, although flower-suckers, have a very poor proboscis.

In discussing the evolution of the various superfamilies, it is common to find authors attempting to trace the origin of a superfamily from an existent genus of another superfamily. This method of attempting to derive directly one superfamily from any existent form, appears to us to be a great mistake, for, as a rule, all that can be said is that two superfamilies (and the same reasoning is applicable to families, subfamilies, tribes and genera) have certain characters in common, and, therefore, both were derived from an ancestor presenting these common features. On this ground it is possible to assert that Endromids, Saturniids and Sphingids, were derived from a common ancestor far back in the history of the evolution of the race. Since the Endromid larva is the most generalised of these at the present time, it is possible to assume that the ancestor possessed more of the present Endromid characters than it did of those characters now possessed by the others, but considering that the existent Endromids and Saturniids are all highly specialised forms, and that both superfamilies have been subjected during recent geological times to similar influences to those that have accompanied the specialisation of the Sphingids, it appears to us to be going too far, to derive the Sphingids either through *Ceratocampa*, *Endromis*, or any other existent genus. The most that can be done is to derive it from Ceratocampid-like or Endromid-like (with a large margin for the "like") ancestors.

The Sphingids form a very large superfamily, the more specialised forms, with their peculiar swift, powerful flight, being eminently fitted for successful competition in the struggle for existence, and also to obtain an almost cosmopolitan range in their distribution.

---

[*] "Life Histories of certain Moths of the families *Ceratocampidae*, *Hemileucidae*, etc.," *Proc. Amer. Phil. Soc.*, 1893, p. 156.

It may be well here to mention that, in our opinion, no more unsatisfactory suggestion for the origin of the Bombycid (Lasiocampid and Saturniid) stirps has been brought forward, than that propounded* by Packard, who attempts to derive it from the Lithosiids. The latter form a highly specialised Arctiid group, differing from what Packard terms the Bombycids in egg, larval, pupal and imaginal characters as widely as can be. We have shown that the tendency of this stirps is for the larval tubercle i to be enlarged, and tubercle ii to become atrophied. In the Liparids, Lithosiids and Arctiids, on the other hand, tubercle ii tends to be enlarged, whilst i becomes atrophied, *e.g.*, the larvæ of *Lithosia complana*, *Callimorpha hera*, etc.

Before leaving our consideration of the larvæ of this stirps, it may be well to recall attention to the fact that, in this stirps, there are traces of extra prolegs on the abdominal segments. We have already referred to those in *Lagoa crispata*, *Chrysopyga undulata*, and other Megalopygids, also to those of the Pterophorid, *Pselnophorus brachydactylus*. It is remarkable that Kowalewski found ten pairs of abdominal prolegs in the embryo of *Sphinx*, one half of which disappeared before hatching, thus leaving the normal number. Tichomiroff found prolegs developed in the embryo of *Bombyx mori* on the abdominal segments 2-10, but those on segments 2, 7, 8 and 9 were absorbed again in a later embryonic stage, and Graber notices that on all the abdominal segments, except the 9th and 10th, of the early embryos of the same species, faintly marked knob-like elevations are to be seen, which may be considered as the first indications of rudimentary appendages. The same author considers that in *B. mori* "the stage of pantopody has only a very ephemeral duration." What value these ephemeral structures have in Bombycid and Sphingid embryos, and what meaning is to be attached to them is not quite clear. We only draw attention to the fact that they appear in the embryos of two specialised superfamilies, where probably homologous structures still occur normally in the larvæ of one of the most generalised superfamilies of the same stirps. It may be noticed here that the mining larvæ of the Nepticulids have nine pairs of abdominal prolegs that bear no terminal crochets or hooks.

The sluggish habits of the larvæ of many of the superfamilies included in this stirps, are probably due to their large size, to the highly developed condition of the prolegs, and to the complex mechanism by means of which walking is accomplished. Anyone who has watched a Saturniid or Sphingid larva walk knows that it cannot hurry. It is probably on account of this slow method of movement that the various larvæ are so remarkably protected by spines or hairs, some of which are of a most complex character. We are inclined to connect these sluggish habits with an arboreal (*i.e.*, as opposed to a ground-feeding) habitat, and have already shown how the larvæ of the large Geometrid superfamily have met the difficulty by protective coloration and a decrease in the number of prolegs, which gives them greater speed and lessens the necessity of other special defensive structures, and yet have maintained their arboreal environment. Packard also connects these sluggish habits with an arboreal condition of life, and asserts that such larvæ are surrounded by a purer air, freer circulation, and more equable temperature, this combination of favourable circumstances causing them to eat more. He says: "The fat, overgrown slugworms (Eucleids) may be compared with the overfed, high-bred pig, which eats voraciously, has little need of rooting, and takes but little exercise. Where, as among cave animals, there is a deficiency of food, we have a constant tendency to slimness, to an attenuation of the body. This is seen in the blind cave Arthropods. . . . . compared with their allies which live under normal conditions."

---

* *Bombycine Moths of America*, pp. 32 and 83.

The generalised superfamilies of the stirps present us with a free, or with an incomplete, pupa, *i.e.*, Pupa-libera and Pupa-incompleta of the earlier authors. Pupæ of the former kind occur in the Micropterygids (?), Nepticulids, Eucleids and Megalopygids, of the latter, in the Anthrocerids, Psychids and Pterophorids, whilst the remaining superfamilies have obtect pupæ, *i.e.*, the Pupa-obtecta of the early authors. These two divisions, therefore, fall into Chapman's two sections, INCOMPLETÆ and OBTECTÆ respectively. The free pupa of the Micropterygids (?), Nepticulids, and Eucleids, probably represents one of the most generalised of all existing forms of lepidopterous pupæ, having all the abdominal incisions movable, and the appendages free, *i.e.*, not soldered. Those of the Anthrocerids, Psychids and Pterophorids, are but little more specialised. They have traces of the "eye-collar" (maxillary palpi), a character almost entirely confined to the most primitive pupal forms, and well-developed in the Nepticulids and Eucleids. In the Anthrocerid pupa the free abdominal segments are 3, 4, 5, 6 and 7 in the male, and 3, 4, 5 and 6 in the female. The Psychid and Pterophorid pupæ are more specialised, having only 4, 5, 6 and 7 free in the male, and 4, 5 and 6 in the female. That of the latter is remarkable also from the fact that it has a well-developed cremaster. It has not, however, a silken central body girth.

When obtect rank is reached there are few structural characters that can be used for differentiation, owing to their uniformity, but it may be noticed that the Lasiocampid pupa has the dorsal head-piece, a character that suggests this as the lowest of the obtect superfamilies of the stirps. The delicate pupal integument is probably another vestigial character. Strangely the obtect pupa of the Endromids has retained the remarkable Micro character of pupal locomotion. This is a peculiar habit exhibited by the pupæ of the more generalised Eucleids, Anthrocerids, etc., by means of which they leave (more or less completely) the cocoon before the emergence of the imago. The same phenomenon is exhibited by certain Sphingid (*Choerocampa*) pupæ, whilst that of *Macrothylacia rubi* travels to and fro in its long cocoon in order to take advantage of the heat of the sun.

As might be expected, the diverse habits of the imagines of the various species comprised in the superfamilies of which this stirps is composed, have resulted in a marvellous difference in the imaginal forms, some of which are extremely specialised, each in its own particular direction. Without going into detail, we have the heavy-bodied Eucleids, Lasiocampids, Endromids and Saturniids, the males with strongly pectinated antennæ, dashing about with exceeding swiftness in the hottest sunshine, the females lethargic by day, and flying heavily by night when ovipositing. There are the microscopic sun-loving Nepticulids, and the dusk-loving Pterophorids. The Anthrocerids (both sexes) boom along heavily only in the hottest sunshine, and are entirely inactive by night; on the other hand, the Sphingids fly swiftly by night, many of the species migrating vast distances, whilst by day they rest on posts, tree-trunks, and similar objects, to which the colour of their roof-shaped wings assimilates.

The shapes of the wings of the various superfamilies follow, to some extent, the habits of the insects. Thus, the Sphingids have long pointed wings that carry them swiftly forward in their long flights; the females of the Eucleids, Lasiocampids, Bombycids, Saturniids, etc., have large wings that enable them to carry their huge egg-laden bodies when ovipositing. No one has yet told us the special value of the peculiar shape of the wings of the plume moths, but the resemblance of some to tiny pieces of dried grass and stick is remarkable, when they have their wings folded up and are at rest, but these will be dealt with at length when we consider the superfamilies individually.

The variability of the habits of the imagines of the different superfamilies of this group is, perhaps, less remarkable than the difference between the habits of the sexes of the same species. Thus in the Eucleids, Lasiocampids, Bombycids, Endromids and Saturniids, as we have said, the male flies swiftly in the hottest sunshine, whilst the female is comparatively sluggish and rarely seen. In the late afternoon or evening the males of almost all these species "assemble" freely to the females (a habit also indulged in during the daytime by the Anthrocerids), the female flying much later for the purpose of oviposition. The huge abdomina of the females of these moths explain the difference, for, in spite of the increase of wing area in this sex, in these superfamilies, the weight of the body prevents the species flying very fast, or to any very great distance. Packard associates this sluggishness with the habit of the females laying their eggs near their cocoons. He says: "When the ancestors of the moths belonging to the Bombycid stirps, became arboreal feeders, the species tended to become segregated. For example, the females of the *Attaci* and their allies, as well as the Cochliopodids may, at first, have had larger wings and smaller bodies, or been more active during flight than their descendants. Their present, heavy, thick bodies and sluggish habits are evidently secondary and adaptive, and these features were perhaps induced by the habit of the females ovipositing directly upon leaving their cocoons, and cocoon-spinning moths are, perhaps, more sluggish and heavy-bodied than those which enter the earth to transform, as witness the *Ceratocampidae*, compared with the cocoon-spinning *Bombyx mori* and the *Attaci*. Spinning their cocoons among the leaves at a period of the earth's history when there was no alternation of winter and summer, and probably only times of drought (as in the dry season of the Tropics at the present time), the females may have gradually formed the habit of depositing their eggs immediately after exclusion, and on the leaves of the trees forming their larval abode. The females thus scarcely used their wings (as in *Callosamia promethea*), the males with their larger wings, lighter bodies, broadly pectinated antennæ, and consequently far keener sense of smell could fly to a greater or less distance in search of their mates" (*Bombycine Moths of America*, p. 19). Among our British species the general principle involved in the above may be largely true, but as a matter of detail, it is open to criticism, for although the females may not wander far to lay their eggs, yet they do wander, and the females of *Endromis versicolor*, *Saturnia pavonia*, *Eutricha quercifolia*, *Lasiocampa quercûs*, *Cosmotriche potatoria*, etc., do not lay all their eggs at one time, nor in one place. Most of these pair where they emerge, lay a batch of eggs near this spot, and then fly a short distance (and probably pair again) before laying another batch. Still, there is, owing to the sluggish habits of the female, a tendency to segregation in all these species.

With regard to the relative age of the various superfamilies belonging to this stirps, Packard says that he has always regarded the Bombycids (the superfamily of silkworm moths) as a very ancient one, which has lost many forms by geological extinction. This accounts for the many gaps between the genera. Both the larvæ and imagines differ structurally *inter se*, much more than do those of the Geometrid and Noctuid moths, and the number of species is less.

The completeness of the two latter superfamilies suggests that their species have been, to a great extent, developed since, or contemporaneously with, the early Tertiary period. On the other hand, Packard supposes that the Bombycids* originated previous to Tertiary, and probably in Cretaceous, times, and he suggests that the plasticity of the Bombycid larval forms, especially in the more generalised families, is due to the great changes in their environment during the Cretaceous and Tertiary periods. In like manner, Packard says, the great gaps in the genera of our existing Bombycids are probably due to geological extinction, and also to the great plasticity or marked difference in the larvæ, as compared with the homogeneousness of the imagines, these being due to the widespread changes in the environment which took place during the late Mesozoic and Tertiary periods, and which reacted on the insects in their early rather than their later stages. Packard further says: "Were fossil Bombycids ever to be found in Europe, we should expect to discover among them representatives of the *Cochliopodidae*, of the Attacine families (*Saturniidae* and *Ceratocampidae*), now characteristic of North and South America, or of the tropical regions of Asia, and perhaps of Africa." He bases this view on the theory that these groups have, to a great extent, become extinct in Europe, but still remain characteristic of the American fauna. He says: "Where a family or subfamily is equally developed both in the Old and New Worlds, we are inclined to suppose that it has been a recently evolved group. It is well known that America has lagged behind Europe, geologically speaking, although America is the older continent as such; the process of specialisation, and then of extinction, has gone on more rapidly in the Old World, or at least the western portion of it" (*Bombycine Moths of America*, p. 32).

Superfamily I: MICROPTERYGIDES.

In Hübner's *Verzeichniss*, etc. (1826), the genus *Micropterix* (*Micropteryx*) was founded to receive three species, *mucidella*, Hb., *podevinella*, Hb. (=*aruncella*, Scop.), and *pusilella*, Hb. (=*calthella*, Linn.) The first species being an *Elachista*, it leaves *aruncella* and *calthella* as representatives of *Micropteryx*, Hb. In 1839, Curtis separated (*Brit. Ent.*, xvi.) the British Micropterygid and Eriocraniid species from *Lampronia* under the name of *Eriocephala*, and cited "*calthella*" as the type. This, of course, made *Eriocephala*, Curt. = *Micropterix*, Hb. for Stephens (1835) had constituted *calthella* tpye of *Micropteryx*. The name *Eriocephala* was maintained in 1850 by Stainton, in his paper* entitled "A monograph of the British species of the genus *Micropteryx* of Zeller," the species then included in the genus *Eriocephala* being the six now known as British, *viz.*, *calthella*, *aruncella*, *seppella*, *aureatella* (*allionella*), *thunbergella* (*rubrifasciella*), and *mansuetella*. Stainton, however, describes (p. 27) *seppella* as *aruncella*, correcting this error, and adding the true *aruncella* in a "Supplemental note" (p. 39). He also included *Phylloporia bistrigella* (*Tinea subammanella*) in the genus.

---

* This term is used by Packard to include the Saturniids and Lasiocampids, as well as the Bombycids proper.

Stainton's diagnoses (corrected) of the species of this genus read as follows:—

I. Head ferruginous.

1.—*Calthella.*—Anterior wings golden-green, with the base entirely purple.

2.—*Seppella.*—♀ Anterior wings golden-green, with the base purple on the costa. ♂ Anterior wings golden-green, with two silvery fasciæ and a small silver costal spot towards apex.

3.—*Aruncella.*—♀ Anterior wings golden-brown, with the costa at the base purple. ♂ Anterior wings golden-brown, with a faint silvery spot near base, and one slender silvery fascia.

4.—*Aureatella.*—Anterior wings purple, with two golden fasciæ, and a golden spot towards the apex, reaching neither margin.

5.—*Thunbergella.*—Anterior wings greenish-golden, with a reddish spot on the costa at the base, a reddish fascia before the middle, and another bifurcate one beyond the middle.

II. Head blue-black.

6.—*Mansuetella.*—Anterior wings greenish-golden, with three very indistinct reddish fasciæ.

Zeller, in 1851, maintained the original use of the generic name *Micropteryx*, and included (*Linn. Entomologica*, v., pp. 322-3) in this genus—*calthella*, *aruncella*, *eximiella*, *myrtetella*, *paykullella*, *allionella*, *subammanella*, *rubrifasciella*, *aglaella*, and *mansuetella*; whilst he placed the "*purpurella* group" in the newly-created subgenus *Eriocrania*, evidently on the ground that Hübner's *Micropteryx* and Curtis' *Eriocephala* are identical, as indeed they are. This division is maintained by Snellen in *De Vlinders van Nederland*, 1882, pp. 1065 *et seq.*

Kirby properly sinks (*Lloyd's Nat. Hist.*, *Lep.*, v., p. 315) *Eriocephala*, Curt., as a synonym of *Micropteryx*, Hb., but says that the type of the latter is *aureatella*, a species not included in Hübner's genus. Following Stephens, it is evident that "*calthella*" should be the type of *Micropteryx* and "*purpurella*" of *Eriocrania*, Zell. It is quite clear, therefore, that Meyrick's use of the name *Eriocephala* for the former group, and *Micropteryx* for the latter, is erroneous. In this work then we shall use the name MICROPTERYGIDES to include *calthella*, *seppella*, *aruncella*, *aureatella*, *mansuetella* and *thunbergella*. We shall also use the name ERIOCRANIIDES for *purpurella*, *subpurpurella*, *semipurpurella*, *sparrmanella*, *unimaculella*, *salopiella*, *sangii*, etc.

Our knowledge of the MICROPTERYGIDES is derived almost entirely from Walter and Chapman, the former of whom first made known the remarkable structure of the headparts of the imago, whilst the latter worked out their life-history, and has told us all that is yet known of their early stages. To Packard is due, in large measure, the assertion of the great value of the facts that Walter and Chapman made known.

---

* *Trans. Ent. Soc. Lond.*, 1850, pp. 26 *et seq.*

So marvellous were the facts brought* to our notice by Chapman, and so far-reaching were the suggestions made as to the relationships of the insects, that it seems difficult even now for us to recognise that insects so different in size, shape, and general appearance, should be related, to the exclusion of others, to families with which one could not suppose they bore any relationship. The presence of characters common to the Micropterygids, Eucleids and Anthrocerids, and absent (so far as is known) in all other Lepidoptera, bespeaks an affinity, in spite of the numberless links that have been extinguished in the course of their evolution.

The Micropterygides, then, form a superfamily containing some of the most ancestral of all Lepidoptera. The species have no near relatives, although the Eriocraniides and Hepialides have been united with them, but the alliance has little more in it than the fact that these three superfamilies are amongst the, if not the, most ancestral of all Lepidoptera, and have had no real connection since a geological time which is almost inconceivable. Through all these ages they have retained certain ancestral characters, and whilst thousands of other forms have come, given rise to new forms, and then disappeared, leaving us only here and there a group that has been able to withstand the climatic and other changes of so vast a geological period, these have gone on, modified, of course, to a great extent, but retaining many of the features that distinguished them, probably as far back as the Carboniferous or Silurian periods. It is possibly this cause that has made the vast gap between the generalised and specialised families of each stirps, for there can be no doubt that many of the latter (*e.g.*, the Geometrids, Noctuids, etc.), have been evolved in recent times, probably in the Tertiary, certainly one would suppose not before the Cretaceous, period. When, therefore, one wonders at the inclusion of the Micropterygides in a stirps of which the highest superfamilies are the Saturniids and the Sphingids, it must not be forgotten that the former are just a little branch of a stem that has divided endlessly, and given rise to a multiplicity of forms under an almost inconceivable variety of conditions, whilst all this time this little superfamily itself has been the sport of the same varying conditions, and yet has retained those characters which enable us to judge of its antiquity.

It is not easy at once to uproot one's cherished associations so as to separate the Micropterygids (Eriocephalids) from the Eriocraniids, with which superficially they appear to have so much in common, especially in size, colour, and neuration; but Chapman's comparison of the two superfamilies (*Trans. Ent. Soc. Lond.*, 1894, p. 336), shows us that Meyrick's attempt (*Handbook*, etc., pp. 802-805) to keep them as genera of the same family is not at all in accordance with the facts at our disposal. There seems, therefore, not only a necessity to place them in different superfamilies, but practically on different stirpes in the classification we have adopted in this work. So far as we at present know, the Palæarctic species belonging to the superfamily Micropterygides are not only referable to the same family, but also to the same genus *Micropteryx*, Hb. (= *Eriocephala*, Curt.). The characters of the genus *Micropteryx* are given† by Chapman as follows:—

---

* "Micro-Lepidoptera whose larvæ are external feeders," *Trans. Ent. Soc. Lond.*, 1894, pp. 335 *et seq.*

† "Some notes on Micro-Lepidoptera," etc., *Trans. Ent. Soc. Lond.*, 1894, p. 336. Revised *in litt.*, May 5th, 1898.

Ovum: Spherical, or where ovoid the ends are alike; opaque; covered with a snow-like coating; laid externally (not in the substance of leaves).

Larva: Short, square, and angular, with ten rows of globular appendages, and eight pairs of abdominal legs of special structure; an anal sucker; two setæ on last segment (possibly cerci); long antennæ; feeding exposed (*i.e.*, not under a web) on moss.

Pupa: (Probably not unlike a *Nepticula*, and in a cocoon above ground. Only the head and antenna-piece seen).

Imago: Six-jointed maxillary palpi, used as feeding-hands; well-developed, serviceable jaws; ovipositor simple, tubular, of three pieces; last abdominal segment the seventh.

Packard also summarises* the characters of the Micropterygides, which, as we have already stated, he erects into a suborder, called Lepidoptera-laciniata or Proto-Lepidoptera, equal in value to the whole of the rest of Lepidoptera, called Lepidoptera-haustellata, as follows :—

I. Imago: Maxilla, with a well-developed lacinia and galea, arising, as in mandibulate insects, from a definite stipes and cardo; the galeæ not elongated, nor united and differentiated into a haustellum, each being separate from its fellow. The maxillary palpi enormous, six-jointed; mandibles large, scarcely vestigial, with a broad-toothed cutting edge, and with three apparently functional hinge processes at the base, as usual in mandibulate insects. Hypopharynx well developed, somewhat as in Diptera and Hymenoptera. The second maxillæ divided into a mala exterior and mala interior, recalling those of mandibulate insects; palpi three-jointed. Thorax with prothorax very much reduced; metathorax very large, with the two halves of the scutum widely separate. Neuration highly generalised; both fore- and hind-wings with the internal lobe or jugum, as in Trichoptera; nervures as in *Micropteryx* (*i.e.*, *Eriocrania*, Zell.), and showing no notable distinction compared with those of that genus; scales generalised; fine scattered setæ present on costal edge and on the nervures; abdomen elongated, with the male genital armature neuropteroid, exserted; the dorsal, lateral and sternal appendages very large.

II. Pupa: Libera (?).

III. Larva: Highly modified in form, compared with that of *Micropteryx* (*i.e.*, *Eriocrania*, Zell.), with large four-jointed antennæ and very large three-jointed maxillary palpi; no spinneret (?); no abdominal prolegs, their place supplied by a pair of tubercles ending in a curved spine on abdominal segments 1—8; a sternal sucker at the end of the body.

IV. Egg: Spherical.

Meyrick diagnoses the imago of *Micropteryx* (*Eriocephala*) as follows: Mandibles developed. No tongue. Labial palpi obsolete. Posterior tibiæ with spurs placed in groups of bristles. Fore-wings: nervure 7 to costa, 11 connected by bar with 12, 12 giving rise to an additional nervure (13) about middle. Hind-wings as fore-wings, but 13 usually absent (*Handbook*, etc., p. 805).

The taxonomic importance of this group is so great that it must be our excuse if we enter somewhat in detail into the characters which it presents. We have already said that for our knowledge of the egg, larval and pupal states, we are indebted entirely to Chapman, whilst we owe our knowledge of the imaginal mouth-parts (which has given so much material for study) mainly to Walter, Chapman having worked out some few details in this direction independently.

With regard to the bearings of the discoveries of these observers on the taxonomy of the Lepidoptera, Packard says: "The presence of two maxillary lobes, homologous with the galea and lacinia of the Mecoptera (*Panorpidae*) and Neuroptera (*Corydalus*, *Myrmeleon*) as well as the lower orders, Dermaptera, Orthoptera, Coleoptera, etc., in what in other important respects also is the "lowest" or most primitive genus of Lepidoptera, the lacinia being a rudimental, scarcely functional, haustellum or tongue, and not merely a vestigial structure, is of great significance from a phylogenetic point of view, besides affording a basis for a division of the Lepidoptera into two grand divisions or suborders, for which we would propose the name LEPIDOPTERA - LACINIATA and LEPIDOPTERA - HAUSTELLATA" (*Bombycine Moths of America*, p. 58).

---

* *Bombycine Moths of America*, p. 61.

The imaginal mouthparts are perhaps the most unusual structures presented by these remarkable insects, and show most strikingly Mecopterid and Neuropterid affinities. It will be well, therefore, to examine these in detail. After stating that the mouth-parts of the lower Micropterygina (*i.e.*, the Micropterygids) exhibit several most primitive characteristics, Walter* shows that the maxillæ are constructed on the type of those of biting or mandibulate insects, *i.e.*, with an inner lobe (galea) and an outer lobe (lacinia) besides the palpi. He writes of the first pair of maxillæ as follows: "In the first pair of maxillæ of *Micropteryx calthella*, *aruncella*, *anderschella*, and *aureatella*, cardo and stipes are present as two clearly separate pieces. The former in *M. calthella* and *M. aruncella*, in comparison with the latter, is larger than in *M. anderschella* and *M. aureatella*. In the last two species, the cardo is still tolerably broad, but reduced. The stipes is considerably longer than the cardo in the last two species, whilst it is of the same thickness. From the stipes arises the large 6-jointed palpus maxillaris, folded two or three times, and concealing the entire front of the head, and all the mouth-parts. At its base, and this is unique among all the Lepidoptera, two entirely separate maxillary lobes arise from the stipes. The external represents the most primitive rudiment (anlage) of a lepidopterous tongue."

With regard to this first pair of maxillæ, Packard writes: "It is evident from Walter's figures and description, that this structure is not a case of reduction by disuse, but that it represents the primitive condition of this lobe, the galea of the maxilla, and this is confirmed by the presence of the lacinia, a lobe of the maxilla not known to exist in any other adult lepidopterous insect, it being the two galeæ, which become elongated, united, and highly specialised, to form the so-called tongue, haustellum, or glossa of all Lepidoptera above the *Micropterygidae* (*Eriocephalidae*), which we may therefore regard as the types of the LEPIDOPTERA-LACINIATA. Another most important feature correlated with this, and not known to exist in LEPIDOPTERA-HAUSTELLATA, is the presence of two lobes of the second maxillæ, besides the three-jointed labial palpi, and which correspond to the 'mala exterior' and the 'mala interior' of the second maxillæ of Dermaptera, Orthoptera, Platyptera, Perlidæ, Termitidæ, and Odonata, and also, as Walter states, to the ligula and paraglossæ of Hymenoptera. In this respect the laciniate Lepidoptera are more generalised insects than the Trichoptera or Mecoptera" (*American Naturalist*, 1895, p. 637).

Walter describes the second pair of maxillæ, each of which consists of two lobes, the outer and inner mala as follows: "Within and at the base of the labial palpi is a pair of chitinous leaves provided with stiff bristles; being the external second lobes of the underlip, formed by the consolidation of the second pair of maxillæ, and which reach, when extended, to about the second third of the length of the second palpal joint. Its inner edge is directly connected with the inner lobe (mala interna). The latter are coalesced into a short, wide tube, which, by the greater size of the hinder wall, opens externally on the point, also appearing as if at the same time cut off obliquely from within outward. The outer exterior edge of the tube forms a strongly chitinous semicircle, which, becoming thinner, finally passes into the delicate membranous hinder wall. Anteriorly a delicate membrane also appears to cover the chitinous portion. We have here in opposition to the weak, naked underlip, represented by a triangular chitinous plate in other Lepidoptera, a true ligula formed by the coalescence of the inner lobes of the second maxillæ into a tube, as in many Hymenoptera, and with free external lobes which correspond to the paraglossæ of Hymenoptera."

---

* *Jenaisch. Zeitsch. f. Naturwiss.*, v., 18 (1884); *Ibid*, v. (1885), pp. 751-807.

With regard to a paired structure which he considers to be the hypopharynx, Walter states: "A portion of the inner surface of the tube-like ligula is covered by a furrow-like band which, close to the inner side, is coalesced with it, and, in position, shape, as well as its appendages or teeth on the edge, may be regarded as nothing else than the hypopharynx." He then continues: "In the Micropterygids (Eriocephalids) the furrow is here coalesced within with the inner side of the labium, and though I see in the entire structure of the head the inner edge of the ligula tube extended under the epipharynx as far as the mandible, I must also accept the fact that here also the hypopharynx extends to the mouth-opening, as in all other sucking insects with a well-developed underlip, *viz.*, the Diptera and Hymenoptera."

Walter further shows that the mandibles also exist in the form of true gnawing jaws, like those of the biting insects. They possess powerful chitinous teeth on the opposed cutting edge, twelve to fifteen on each mandible and also the typical articulating hook-like processes by which they are joined to the gena, and fit in corresponding cavities in the latter. In *Eriocrania*, and other of the more generalised moths, the mandibles in a very reduced form have survived as functionless vestiges of the condition in *Micropteryx* (*Eriocephala*).

Kellogg, in a paper* that would have been much more useful than it is, had it not been for the mixing up of the Micropterygid (Eriocephalid) and Eriocraniid species in his examination, states that in *M. anderschella*, it appears to him to be the outer lobes of the maxillæ which seem to be free, while the inner ones go to form the very rudimentary proboscis referred to by Walter. However, he is not at all satisfied (nor clear) on the matter, and prefers to leave it open.

As to the use to which the remarkable mouth structures of the imagines may be put, Chapman says that they use their great claw-like maxillary palpi with sharp knife points to scrape and tear at both the pollen of the stamens and the surface of the petals, in the latter case, perhaps, collecting fallen pollen. They certainly do something very like eating as regards this pollen, and digest and use it, as would appear from two circumstances: firstly, that very slender moths get very fat, and lay many eggs, and, secondly, their dejecta are very abundant. Moths will live in confinement for three weeks if fed in this way, and kept damp enough. The imagines pair readily, and apparently do so more than once.

---

* "The mouth-parts of the Lepidoptera," *American Naturalist*, 1895, pp. 546 *et seq.*

Packard finds other primitive characters in the head and trunk. He says: "The head is of moderate size, as well as the body, with small compound eyes, and with two ocelli. The occipital region is well developed, as is the epicranium; the clypeus and labrum are of moderate size. The generalised nature of the thorax is especially noteworthy. The prothorax is seen to be very much reduced, the two tergites being separate and minute, not readily seen from above. The rest of the thorax is very long, exhibiting but little concentration. The mesothorax is but slightly larger than the metathorax. The mesoscutum is very short; the scutellum rather triangular than scutellate. The metathorax is but little shorter and smaller than the mesothorax, and remarkable for the widely separated halves of the scutum, a neuropterous character (compare *Ascalaphus* and *Corydalus*), in which it differs from *Micropteryx* (*i.e.*, *Eriocrania*). The shape of the scutellum is that of a low flattened triangle. As regards the abdomen, attention should be called to the disparity in size and shape between the sexes; also to the male genital armature, which is very large, and completely exserted, and reminds us of that of *Corydalus*, in which, however, the lateral claspers are much reduced; and also of that of certain Trichoptera (*Sericostoma*, *Tinodes*, *Stenophylax*, *Hydropsyche*, etc.). The neuration of both pairs of wings is much as in *Micropteryx* (*i.e.*, *Eriocrania*)" [*Bombycine Moths*, etc. p.59].

Kellogg has shown* that in the Micropterygids (*mansuetella*, *thunbergella*, *seppella* and *anderschella*), there are, in common with the Eriocraniids (*unimaculella*, *sparrmanella*, *fastuosella*, *semipurpurella*), and Hepialids (*sylvinus*, *gracilis*, *humuli*, *argentata*, *hecta*, *purpurascens*, etc.), besides the specialised lepidopterous scales arranged in regular rows or tiers over the membrane, a covering of very fine hairs, differing radically from the true scales, in size, arrangement, and mode of attachment to the membrane. These minute hairs have not yet been discovered in any superfamily other than the three referred to the JUGATÆ. This clothing of the wings is considered to be essentially that of the Trichoptera, only in a more specialised condition. He also states† that the well-known scale-hairs of the Trichoptera are simply the true lepidopterous scale in a generalised condition, and that there are many instances among the caddis-flies (*Setodes*, *Mystacides*, etc.), of the presence of well-developed scales.

Chapman states that the Micropterygid (Eriocephalid) larva is the only other "Micro" larva (not mining or feeding internally or under a web) having a similar form to the larvæ of Anthrocerids and Eucleids (Limacodids). He further considers that the suckers on the first eight abdominal segments of the Eucleid larva, are probably homologous with prolegs, and also with the eight pairs of abdominal legs of *Micropteryx* (*Eriocephala*). Chapman also says that the long spines (described later) which develop rapidly in the larva of *Apoda avellana* at the period of hatching, correspond in position with no larval processes known, except those of *Micropteryx*. In the former, the dorsal series on one side, though consisting of one spine on each segment, has

---

* "Classification of the Lepidoptera," *American Naturalist*, 1895, pp. 250 *et seq.*

† "Affinities of the Lepidopterous wing," *American Naturalist*, 1895, pp. 709 *et seq.*

them placed as though they were the double rows of *Micropteryx*, with alternate spines omitted, *i.e.*, the inner spine is wanting on the first abdominal segment, the outer one on the second, and so on alternately; laterally the spines appear to belong to the lower row of the lateral series of *Micropteryx*, but the upper row is represented on the thorax by two spines. A further point of resemblance in these spines to those of *Micropteryx* is in their peculiar spiculate apex, which reminds one much of the peculiar stellate spiculæ of the knobs of *Micropteryx*.

With regard to the structure of the larva, Dyar* says: "The setæ are highly modified, and their arrangement has been much specialised, as shown by the fact that the last two thoracic segments are like those of the abdomen. This is the case in no generalised type, and has only been so perfectly attained in some of the highest lines of development in the Frenatæ. . . . . The curious abdominal legs are unique in the Lepidoptera. Probably they have been derived secondarily, and have no homologues elsewhere." This, as will be seen from the preceding paragraph, is not Chapman's opinion, since he homologises the abdominal legs of *Micropteryx* (*Eriocephala*) with the suckers of the Eucleid larva.

Chapman considers that the two long setæ on the 10th abdominal segment of the larva are homologous with cerci rather than with any ordinary tubercles or processes of lepidopterous larvæ, and, comparing these larvæ with those of *Panorpa*, he points out that, in the disposition of the tubercles and of the abdominal prolegs, the resemblance between them is very close. The idea that the bristles on the last abdominal segment are cerci, requires fuller investigation. It seems impossible to correlate them with any of the ordinary appendages of lepidopterous larvæ, since they are only bristle-like appendages, and are quite different from the ball appendages of the Eriocephalid larva that probably represent the usual tubercles in other lepidopterous larvæ. It is to be remembered that, though called bristles, they are of very large size (for bristles) in comparison with the larva itself, and their structure has not yet been investigated (Chapman, *in litt.*, March 25th, 1898).

The Micropterygid egg is very remarkable. Those of *M. calthella* and *M. seppella* are spherical, but eggs of *M. ammanella*, Hb. (= *anderschella*, H.-S. *nec* Hb.), obtained by Chapman, whilst we were at Cannes in April last (1898), were obviously rather oval than spherical. The size of a batch of eggs laid by a single moth exceeds in volume that of the moth itself. This is due not so much to the size of each individual egg as to the fact that the marvellous mealy or snowy appearance of the egg-shell is developed after the egg is laid, and swells the latter out to a much larger size than when it is first deposited. There can be no doubt that the tiny points which give the egg this mealy appearance prevent, as it were, close contact between the egg and the object (moss ?), often very damp, upon which it is laid. The eggs are laid in little masses, sometimes one heap contains from 70 to 80 ova.

Meyrick says that the Micropterygids (Eriocephalids) consist of about a score of species, inhabiting especially S. Europe, Asia Minor, Syria, and North Africa. The imagines frequent blossoms (*Carex*, etc.), feeding on pollen. He further says that the New Zealand genus *Palaeomicra* is the most ancient known. It differs from *Micropteryx* in still retaining the following ancestral characters, *viz.*, the trifurcation of nervure 1*b* (in one species), the sub-basal bar between the parting nervure and upper cell-margin, the additional nervure rising out of 11, and (in one species) a second additional nervure rising out of 12, near base, etc. Walsingham writes: "A re-examination of my North American *Micropteryx pardella* and *M. auricrinella* shows them to belong to a new genus (which I have described in MS. as *Epimartyria*), resembling *Eriocrania* in general appearance, but having the jaw structure, without tongue, of a true *Micropteryx*, and with very peculiar antennæ. *Epimartyria*, therefore, is the American representative of *Micropteryx* (*Eriocephala*, Crt.) with developed mandibles. There is no evidence, however, that the true genus *Micropteryx* (*Eriocephala*) occurs in the United States, although *Eriocrania* undoubtedly does so" (*in litt.*, April 30th, 1898).

---

* "Classification of the Lepidoptera on Larval characters," *American Naturalist*, 1895, pp. 1066 *et seq.*

Frey makes (*Ent. Annual*, 1858, p. 142) a remarkable statement as to the probable food-plants of the Micropterygids (and Eriocraniids). He says: "The family of the *Micropterygidae*, containing the single genus *Micropteryx*, has only eight species which occur in Switzerland. The half of these, *i.e.*, four, have been noticed on the higher Alps, *viz.*, *calthella*, *aruncella*, *allionella*, and *anderschella*, often at considerable elevations. Certainly the larvæ live not only in the wood of trees, but also on low bushes and hard-stemmed plants." The larvæ of *Eriocrania*, of course, are now well known to mine in leaves (principally birch) and since it has been proved that the Micropterygids are moss-feeders, one wonders why Frey made the statement that the larvæ live "in the wood of trees." The four species mentioned by Frey as occurring "on the higher Alps" are all Micropterygids, not Eriocraniids.

The imagines fly in the sunshine chiefly in May and June, in Britain, and frequent flowers. *Micropteryx* (*Eriocephala*) *calthella* is sometimes to be seen in hundreds in the morning sun, in the flowers of *Caltha*, *Ranunculus*, etc., revelling in the pollen in early May, or even late in April. *M. seppella* is reputed to prefer the flowers of *Veronica*, whilst *M. thunbergella* is usually associated with a preference for pine cones. *M. mansuetella*, *M. aureatella* and *M. thunbergella*, all appear in May and June, the latest British species probably being *M. seppella*, which is often taken during the first fortnight of July. There is no doubt that the fondness shown by the imagines of the various species for special flowers, is due, not so much to the fact that this is the favourite food of the species, as to its being the prominent available plant of their habitat. They go to the flowers to obtain the pollen for food, and the continuous references of certain species to certain flowers, *e.g.*, *M. calthella* to *Caltha* and *Ranunculus*, *M. aruncella* to *Spiraea*, *M. seppella* to *Veronica*, etc., simply points out perhaps the most conspicuous plant which provides the required staminal food at the time of their occurrence. When *Caltha*, for example, grows in shady swamps, *M. calthella* is found in the flowers, but if it grows in open swamps and bogs there are often no *M. calthella* to go to it. Gardner finds both *M. seppella* and *M. calthella* in abundance, in the flowers of *Rosa spinosissima*, on the sandhills near Hartlepool, the insects evidently availing themselves of the most readily obtainable flowers to satisfy their own wants.

Family: MICROPTERYGIDÆ.

So little is known of this family that its sub-divisions, even generically, are not at all well-defined. Nothing whatever has been recorded, of the early stages of either the American or New Zealand species. The genus *Epimartyria*, Wlsm., is, so far as is at present known, confined to the United States. The genera *Mnesarchaea*, Meyr., and *Palaeomicra*, Meyr., have, until now, only been found in New Zealand. The genus *Micropteryx*, Hb., is confined to the Palaearctic area. Whether these genera belong to the same family or not, we are not in a position to say. The following is a complete list of the known species belonging to the superfamily Micropterygides. For this, we are indebted to Lord Walsingham and Mr. J. H. Durrant.

Superfamily: **Micropterygides.**
 Family: MICROPTERYGIDÆ.
  Subfamily: *MICROPTERYGINÆ.*
   Genus: Palæomicra, Meyr.
    chalcophanes, Meyr.
    chrysargyra, Meyr.
    zonodoxa, Meyr.
    doroxena, Meyr.
   Genus: Mnesarchæa, Meyr.
    paracosma, Meyr.
    loxoscia, Meyr.
    hemadelpha, Meyr.
   Genus: Epimartyria, Wlsm.
    pardella, Wlsm.
    auricrinella, Wlsm.
   Genus: Micropteryx, Hb.
    calthella, Linn.
    amasiella, Staud.
    auropulverella, Evers.
    aruncella, Scop.
    ? seppella, Fab.
    ? eximiella, Zell.
    ? atricapilla, Wk.
    berytella, de Joann.
    maschukella, Alph.
    aglaella, Dup.
    mansuetella, Zell.
    algeriella, Rag.
    myrtetella, Zell.
    elegans, Sta.
    imperfectella, Staud.
    paykullella,, Fab.
    rablensis, Zell.
    ? rothenbachii, Frey
    ammanella, Hb.
    aureatella, Scop.
    completella, Staud.
    wockei, Staud.
    thunbergella, Fab.

Genus: MICROPTERYX, Hb.

Synonymy.—Genus: *Micropterix* (rect. *Micropteryx*), Hb., "Verz. bek. Schmett.," 426 (1826) [including: (1) *Mucidella*, Hb. 435 (? *Elachista*). (2) *Aruncella*, Scop. [= *podevinella*, Hb., 342 (Z.)]. (3) *Calthella*, L. [= *pusilella*, Hb., 341 (Zk.)]. Stephs., "Ill. Brit. Ent. Haust.," iv. (361), 423 (1835); Zell., "Linn. Ent.," v., pp. 322 *et seq*. (1851); Frey, "Die Tineen," etc., p. 46 (in part); Sta., "Man.," ii., pp. 302 *et seq*. (in part); Staud. and Wocke, "Cat.," (1871) p. 340, in part; Snellen, "Vlinders," etc., p. 1065; Kirby, "Handbook," etc., v., 315. *Eriocephala*, Curt., "Brit. Ent.," exp. Pl. 751 (1839); Stainton, "Monograph, Tr. Ent. Soc. Lon.," p. 27 (1850); Heinemann and Wocke, "Schmett Deutsch.," ii., p. 772 (1876); Chapman, "Trans. Ent. Soc. Lond.," 1894, pp. 339 *et. seq.*; Meyr., "Handbook," etc., p. 805 (1895).

Kirby specifies (*Handbook*, etc., v., 315) *aureatella*, Sc., as the type. This species was not included by Hübner in the genus.

MICROPTERYX CALTHELLA, Linn.

Synonymy.—Genus: *Micropteryx*, Hb. (Type, *M. calthella*). Species: *Calthella*, Linn., "Fauna Suec.," No. 1,432, p. 367 (1761), "Sys. Nat.," xii., p. 895 (1767); Fab., "Sys. Ent.," 663, 47 (1775); Schiff., "Sys. Verz.," 144; Schrank, "Fn. Boica," ii., 2, 124; Haw., "Lep. Brit.," iv. (*a* ♀ and γ ♂), p. 573; Tr., "Eur. Schmett.," ix., 2, 117; Dup., "Hist. Nat.," xi., p. 401, Pl. 302, fig. 6; Stphs., "Ill.," iv., 361; Curt., "Brit. Ent.," xvi., pl. 751; Wood, "Index Ent.," no. 1599; Zell., "Isis" (1839) p. 185; "Linn. Ent.," v., p. 323; Zett., "Ins. Lapp.," p. 1008; Evers., "Fauna Lep. Volg.-Ural.," 587, 2; Tgstr., "Bidr.," 115; Sta., "Tr. Ent. Soc. Lond.," 1850, p. 28, Pl. iii., figs. 1-4; "Ins. Brit.," 42; H.-Sch., "Sys. Bear.," v., p. 391; Frey, "Die Tineen," etc., p. 48; Sta., "Man.," ii., p. 302; Stdgr. and Wocke, "Cat.," p. 340; Heinemann and Wocke, "Schmett. Deutsch.," ii., p. 772; Herklots, "Bouwstoffen Fauna Ned.," etc., iii., p. 216, no. 35; Snellen, "Vlinders," etc., ii., p. 1065; Meyrick, "Handbook," etc., p. 806: Tutt, "Brit. Moths," p. 356. *Sulcatella*, Bent., "Zoologist," iii., 1086 (1845). *Pusilella*, Hb., 341 (1816); (Zell., "Isis," 1839, p. 185). ? *Isobasella*, Stdgr., "Berl. Ent. Zeits.," 1870, p. 289; Hein. and Wocke, "Schmett. Deutsch.," ii., p. 772 (1876). *Urticaella*, Costa (1836).

ORIGINAL DESCRIPTION. — *Phalaena Tinea calthella.* Atra, alis superioribus totis aureis, capite ferrugineo. Minuta. Antennæ vix corporis longitudinæ. Alæ superiores certo situ totæ aureæ apparent: alias atræ. Differt a *Ph. frischella* antennis basi minime auritis, capite ferrugineo; corpore quadruplo minore. Habitat in floribus *Calthae* frequens (Linné, *Fauna Suecicae*, ed. ii., No. 1432 p. 367). To this he adds: "Habitat in *Caltha palustris* floribus" (*Sys., Nat.*, xiith ed., p. 895).

IMAGO.—Fore-wings, 7-9mm.; unicolorous greenish-golden (and usually with the base from the costa to the inner margin purple). Hind-wings bronzy-grey, the apical area tinted with purplish.

SEXUAL DIMORPHISM.—The head of the male is yellowish, of the female, ferruginous. The male is much smaller than the female.

VARIATION.—Zeller describes (*Linn. Ent.*, v., p. 323) two forms of the species:—

a.—Capillis ferrugineis, alis anterioribus virescenti-aureis (post mortem sulcatis), basi purpurea.

b.—Al. ant. basi vix purpurea, ♀.

It is quite clear that var. *b.* is, if both forms be referable to *M. calthella*, the Linnean type, the latter of which has the fore-wings uniformly golden, and not purple at the base. The common form (ab. *a*) might, unless this be a purely sexual difference, be called ab. *purpurascens*. Atmore says that at King's Lynn some specimens have a purplish-brown tint towards the apex of the wings. Zeller's var. *b.*, which we have suggested, may be the Linnean type, appears to be the form described by Staudinger, as *M. isobasella* [*Berl. Ent. Zeit.*, xiv., p. 289 (1870); Hein., ii., p. 772 (1876)]. This is directly referred to by Snellen as *calthella* var. *isobasella* [*Vlind.*, ii., p. 1065 (1882)], but if it be really this species, then *M. isobasella*, Stdgr. is a synonym of *calthella*, Linn., and the purple-based form (erroneously considered by Staudinger as the type) will be called ab. *purpurascens*, n. ab. Considering the uncertainty existing as to the specific distinctness of *isobasella*, it may be well to quote the description of Staudinger, who writes as follows: "69. *Micropteryx isobasella*, n. sp. (? *calthella* var. *b*, Zell., *Linn. Ent.*, v., p. 323). I took a pair of this insect last year on July 8th, on flowering bushes, in the evening, at Macugnaga, among numbers of *M. aruncella*, which was there common. The two specimens, nearly 10 mm. in expanse, are accordingly but little larger than *calthella*, and perhaps only a local form thereof. Since they have entirely unicolorous, shining green fore-wings, without the trace of a violet base, they agree in so far with the var. *b* described by Zeller (*l. c.*). On the other hand, their hind-wings are very strongly violet-coloured, much more strongly than any German *calthella*. Moreover, the fringes of the fore-wings at their base, especially in the female, have a very beautiful violet-purple gloss which does not occur in *calthella*. The rust-yellow hairs of the head, length of antennæ and the thorax are as in *calthella*, but the small shoulder covers (epaulettes) are scarcely tinged with violet. Whether we have to do here with a species or a local form of *calthella*, can only be established by a large number of examples from various localities" [*Berl. Ent. Zeit.*, xiv., 289 (1870)]. Durrant inclines to the opinion that *isobasella* is distinct.

Comparison of M. calthella with ♀ M. seppella.—The absence of the silvery fasciæ that characterise the male of *M. seppella*, makes the female very similar to *M. calthella*. Bentley who first discovered the similarity in Britain, unfortunately re-named *M. calthella*, calling it *sulcatella*, and applied the name *calthella* to ♀ *M. seppella*. Although there is a form of *M. calthella* without the purple base it rarely occurs in this country (and we believe is equally rare in Germany), and hence, perhaps, arises Stainton's distinction that the purple at the base of the wing extends to the inner margin in *M. calthella*, whereas in *M. seppella*, it never reaches it. The former also is said to have (when dead) a more sulcated appearance.

Egg-laying.—The ovipositor is quite short, simple and tubular, the egg is large and spherical, laid among moss. Chapman says that the female, when laying, creeps down among the moss to a depth of an inch or more, and seems anxious to get to the bottom and lay her eggs on the bottom of the jar, sand or earth. If the stratum be too deep for this, she will lay them on a spray of the moss, always in little groups, rarely as few as two or three, usually six to ten, and even more, as many as twenty-five having been counted. The female will often remain and die beside her last batch of eggs.

Ovum.—The ova are spherical, 0·46mm. in diameter, almost white. They have a snowy, mealy look, owing to the provision of a close coating of minute rods standing vertically on the surface of the egg, and often tipped with a small bulb (of fluid ?) ; whether these are appressed to the surface of the egg when laid, or whether they afterwards develop in some other way, I do not know, but I think the latter. Their function would appear to be to protect the egg from too close contact with the possibly very wet surface on which it lies (Chapman).

Habits of larva.—Chapman says[*] that about the middle of August, 1892, he found several larvæ about 1·5 mm. in length, and though so much larger than when newly hatched, were otherwise precisely the same in all respects. They were kept very wet, the moss (*Hypnum praelongum*) dripping, and the sand below under water, and the result was decidedly satisfactory, as, at the end of September, the moss was still growing, and the larvæ usually to be seen. On October 21st, there were three larvæ in the jar, the two largest measuring, with the head retracted, 3·5 mm. in length, and, therefore, probably full-grown. About this time several were found in another jar in which moss was growing, but which had been kept much too dry ; these were only about 1·5 mm. long, and another larva was found in another jar. At this time, Chapman saw one of the larger larvæ actually eating the delicate stem of growing moss, of which a considerable piece of one side had disappeared. The larvæ seemed to be constantly on the move, at times not to be seen, and when seen, always in a fresh place ; they walk slowly but steadily, using the abdominal appendages as legs, and often raising the fore part of the body and stretching about as if in search of something. Judged by the sizes of their heads, there were at least three stages of the larva on October 21st, which, with the newly-hatched one, made four stages observed, although, no doubt, there would be one or two intermediate stages between the young larva and the smallest seen at this date. The intestinal contents, so far as they are visible through the larva, were, in one instance, green, in two others, brownish. Occasionally, a good end view of the larva is seen, and then its angularity (on cross-section) is very evident, the spaces between the double rows of processes being hollow, and the processes placed on the angles of a flat, raised surface. The long antennæ, Chapman says, have an elegant curvature, and are placed on the head so as to look, as it moves from side to side, ridiculously like the horns on a Hereford ox—the proportionate length of horn to head being not very different in the two cases. In 1893, Chapman obtained a large number of eggs and young larvæ, and early in November discovered two full-grown larvæ. The remainder seem to have perished.

---

[*] *Trans. Ent. Soc. Lond.*, 1894, pp. 339 *et seq.*

Larva.—The young larva is altogether unlike our ideas of a lepidopterous insect. It is very delicate, and shrivels rapidly by desiccation when removed from its natural habitat in damp moss. The peculiarities of its form and structure may be stated to be its angular outline, the possession of a number of remarkable appendages to each segment, of eight pairs of abdominal legs of unusual structure, and of an oval sucker; that the antennæ are remarkably long for a lepidopterous larva, and that the head is retractile, so far, that it may occupy the interior of the mesothoracic segment. The larva does not appear to alter these characters during its growth to maturity. The antennæ of the adult larva are not, perhaps, proportionately so long, and the abdominal legs have shorter and thicker bases.

The larva is thick and short and fairly cylindrical, apart from its angular section, and tapers very little, terminating rather abruptly at either end, especially when sulky and with retracted head. The angular outline is due to ten (not eight as first described) rows of peculiar appendages, so disposed as to form two subdorsal rows and two lateral rows on either side, each double row arising from the angles of a raised ridge, and the intervening spaces being rather hollowed. Another row low down on either side homologises with the row of prolegs on its own side, thus making, with the prolegs, 12 rows of appendages arranged in pairs. The general surface is raised in ridges, or rather marked by sulci that are chiefly transverse in direction, but communicate with each other to form a network, and, in places, make a beautiful rosetted pattern. The general result is a division of each segment into five subsegments, the balls or appendages are on the third of these. The fourth and fifth, in the centre of the dorsum and again in the centre of the space between the subdorsal and lateral pairs of ridges, are united into one by a circular area, in the centre of which is a dot or spot. This description applies to the mesothorax, metathorax, and the first to seventh abdominal segments. The prothorax has two transverse rows of ball appendages, with six in the first row and four in the second. On the 8th abdominal segment, the appendages are similarly in two rows, but deficient in number, there being only eight altogether; whilst on the 9th abdominal segment there are only six. These appendages on the 8th and 9th abdominal segments are longer, larger and more club-shaped, and project backwards from their points of attachment; those on the other segments are shorter and more rounded, and are directed forward; those on the prothorax are, however, similarly a little larger and longer than the others. These appendages arise from special ball-like points, encircled by a special area, and are globular in form, or, in some cases, nearly pyriform, with a definite neck or stalk; they are dotted as though with spiculæ in a rectangular pattern, and appear to have some internal ribbing or skeleton (which remains stiff in a mounted specimen, whilst the surface loses its plumpness and shrivels). There are eight pairs of abdominal legs one pair on each of the first eight abdominal segments, arranged so as to suggest that this double row is a modification of the double rows of appendages on the upper surface. These legs are, however, of a very different structure from the balls of the upper surface, and also from the true legs on the thoracic segments. They consist of a large stem or shaft with, both towards the base and apex, some doubtful spicular projections; this shaft is apparently cylindrical, and contains a body which is either a vessel or tube, or a tendon to the terminal claw. The shaft arises from a conical base to which it is not distinctly jointed, but is rather continuous with it. The terminal piece is a very distinct and separate structure, in general outline much like the terminal joint or claw of a thoracic leg, but with the sharp apex rounded off, the convexity is directed forwards (not inwards). It is of homogeneous, semi-transparent texture, but marked by oblique lines, which suggest, whether correctly or not I cannot say, that the surface between them is raised in rounded ridges, which pass round the anterior and posterior edges and make it look like a conventional cornucopia. (In preserved specimens the shafts of these legs seem laterally compressed). Another structure is a sucker on the undersurface of the 9th and 10th abdominal segments, or possibly only on the 10th, the 9th being very narrow in front of it; its form is trefoil with one leaf forwards. This sucker, on a lepidopterous larva, is, of course, very unusual, and is a further point of relationship to the Limacodids. The 10th abdominal segment carries dorsally two hairs. The true legs besides the base, which is a little full and raised, consist of three joints, and much resemble the thoracic legs of an ordinary lepidopterous larva. The first large joint has two spurs on its inner margin, about the middle, and two or three hairs on the same zone, laterally and dorsally; the second more slender joint is rather longer, and narrows about the middle, where there is a spur or bristle on its inner margin; on the outer side at its extremity, is an indication of a bristle or two, but no definite appendage. The last joint is again rather shorter, and terminates in a sharp point. The head is rather longer than broad, and narrows a little forwards; there are two strong mandibles, with four brown teeth. The antennæ are very long, about equal in length to the transverse diameter of the head; there are two short, thick basal segments, as to the first of which I am not very sure, whether it is a true segment or a basal projection; there are two long segments about equal in length, and a nearly as long terminal joint, which is little more than a seta in thickness. Two pairs of palpi are also visible —two and three-jointed—apparently similar to those usual in lepidopterous larvæ. There is also a central point (spinneret?) [Chapman].

Cocoon.—The cocoon is described by Chapman as being fairly tough, composed of yellowish silk, and with scraps of moss coating it, ovoid, 3 mm. long, and 1·5 mm. broad.

Pupa.—The only recorded observation on the pupa of this superfamily was made by Chapman, who found an imago of *M. calthella* with a portion of the headpiece of the pupa attached to an antenna. This showed the pupa to be of the "Incomplete" or "Micro" type, *i.e.*, it consisted of the covering of the antennæ, head, and head-appendages in one piece. This observation renders tolerably certain what was antecedently probable, that the pupa is of "Micro" type, with the third and following abdominal segments free.

Food-plant.—Probably various species of *Hypnum*, the larvæ fed on *H. praelongum*, *tamariscinum* and *swartzii*.

Habitat.—Often to be found in abundance in various species of buttercups (*Caltha*, etc.) in openings in woods, fields near woods, and similar places. We have seen as many as a dozen in a single flower of *Ranunculus bulbosus* and *R. acris*, in the rides of Chattenden Woods, all very busily engaged eating the pollen. It is commonest on the flowers of buttercups and carices, but also in and about many other flowers, *e.g.*, *Scilla nutans*, *Veronica chamaedrys*, *Lysimachia nemorum*, etc. Linné mentions it as common in the flowers of *Caltha palustris*, and Zeller states that although it is to be found sitting in company in the flowers of the latter plant, he finds it more common in those of *Ranunculus repens* and *R. acris* on the borders of woods. Inchbald has found it commonly in the blossoms of *Galium verum*, and South on the flowers of *Ranunculus bulbosus*, growing by roadsides near water. Barrett says that where there are no flowers of *Caltha palustris*, or buttercup, the species frequents those of *Cardamine pratensis*, and even those of stitchwort and spurge. He states that he has also seen it commonly running over hazel leaves in the copses. Fletcher says that at Worthing it is very common on small carices. Zetterstedt notices that he has often captured them *in copulâ*, in the flowers of *Caltha palustris*. Bower has found them on flowers of *Mercurialis perennis*, and buttercup, as well as flying in the afternoon sun. Corbett says that in various parts of Yorkshire the species frequents the grassy sides of the rides of woods, where it swarms on flowers of *Ranunculus bulbosus*. He states that he has never seen it on *Caltha*, the flowering time of the latter being usually over before *M. calthella* is out. He has counted as many as 30 moths on one flower of *R. bulbosus* and they are frequently found *in copulâ* on the flowers. At Wareham, it is especially abundant in the blossoms of *Caltha* in swampy places in May (Cambridge). In the King's Lynn, district it is common; it was exceedingly abundant in 1884 and 1890, in flowers of a *Carex*. It is also attached to *Caltha palustris*, and species of *Ranunculus*, especially *repens*; it is sometimes common on the male flowers of *Mercurialis perennis*, and more than once noticed commonly on flowers of *Sambucus niger* and *Endymion nutans* (Atmore). In the Reading district it prefers damp places, and the imago is found on the blossoms of *Caltha* (Hamm). In the Carlisle district it is found on the "mosses" (Wilkinson). In flowers of *Ranunculus*, *Mercurialis*, and *Carex*, near Manchester (Chappell). In the Forest of Soignies to the south of Brussels, sitting on the flowers of buttercups and *Carex* (Stainton).

Time of appearance.—Zeller says that it appears at the end of April in Sicily and in Germany (Glogau) in May; Zetterstedt gives it as appearing in southern Lapland, from June 10th-27th, whilst in the northern part of Lapland (Stensele and Brattiksfjell) he has captured it from July 1st-8th. Eversmann gives July and August for the Ural district (a record that Zeller considers to be erroneous). In the southern counties of England, it is usually out in early May—Stainton bred a specimen on April 13th, 1855, in a tin in which were only a piece of decayed wood, a plant of *Dactylis*, and a plant of *Carex*. Actual dates of the occurrence of the species are as follows:—

May 22nd, 1890, at Calcot (Robertson); May 19th, 1888 and April 29th, 1893, at Chattenden (Tutt); May 18th-31st, 1866, at Haslemere, and May, 1860, at Powerscourt (Barrett); May 21st, 1893, nr. Southend (Whittle); June 2nd, 1887, at West Wickham; June 4th, 1887, at Eltham; May 28th, 1890, at High Force; June 1st, 1891, May 17th, 1892, at Bexley; June 5th, 1891, at Greenhithe; July 29th, 1892, at Sanderstead (Bower). The time of appearance varies according to the season from the middle of May to middle of June in Yorkshire, taken May 4th, 1890; June 12th, 1891; May 19th, 1893, at Wheatley Wood, and May 20th, 1897, at Cusworth (Corbett); May 12th-15th, 1881; May 13th-18th, 1882; May 10th-16th, 1883; May 6th-21st, 1884; May 10th-16th, 1885; May 12th-16th, 1886; May 9th-20th, 1887; May 14th-20th, 1888; May 13th-23rd, 1889; May 12th-18th, 1890; May 16th-26th, 1891; May 15th-24th, 1892; May 12th-23rd, 1893; May 13th-26th, 1894; May 14th-26th, 1895; May 12th-24th, 1896; May 16th-18th, 1897, at King's Lynn (E. A. Atmore): May 5th, 1890. at Bloxworth (Cambridge); June 27th, 1895, at Corstorphine Hill; and July 5th, 1895, at Ormiston, E. Lothian (Evans); May 16th, 1876, at Preston and June 16th, 1877, at Windermere (Threlfall); May 22nd, 1888, May 12th, 1890, June 2nd, 1891, at Merton (Durrant).

Localities.—Aberdeen: near Ben-na-chie (Reid). Berks: Calcot (Robertson), Reading (Hamm), Tilehurst and Pangbourne (Holland). Cambridge: Cambridge (Stainton), Wicken Fen (Farren). Carmarthen: Llangennech (Richardson). Cheshire: Bromborough Wood (Ellis), Dunham Park and Knutsford (Chappell), Patrick Wood, near Bromborough and New Brighton (Gregson). Cumberland: Lake District (Stainton), Carlisle (Wilkinson), Hayton Moss (Routledge). Derby: Burton-on-Trent (Harris), Repton (Spilsbury). Devon: North Devon (South). Dorset: Purbeck, Portland (Richardson). Bloxworth (Cambridge). Durham: Darlington (Stainton), High Force (Bower), Hesleden Dene (Gardner). Edinburgh: Corstorphine Hill (Evans). Essex: near Southend (Whittle). Gloucester: near Bristol (Mason). Haddington: Ormiston (Evans). Hants: Pamber Forest (Holland), northern part of county included in Reading district (Hamm). Hereford: Tarrington (Wood), Leominster (Hutchinson), Hereford (Chapman). Kent: Alkham and Tenterden (Stainton), Cuxton and Chattenden (Tutt), West Wickham, Eltham, Bexley and Greenhithe (Bower), Pembury (Stainton). Lancashire: Manchester (Chappell), Childwall (Gregson), Grange and Preston (Threlfall), Otterspool, near Liverpool (Ellis), Withington (Chappell), Warrington (Cooke). Leicester; Market Harboro' (Matthews). Middlesex: Kingsbury (Stainton). Norfolk: King's Lynn, Merton and Norwich (Atmore). Northumberland: Newcastle (Stainton), Morpeth and Old Park, Netherwitton (Finlay). Oxon: Part of county within Reading district (Hamm), Warren (Holland). Somerset: Castle Cary (Macmillan), Portishead (Mason). Suffolk: Blaxhall (Harker). Surrey: Haslemere (Barrett), Sanderstead (Bower). Sussex: Lewes (Stainton), Worthing (Fletcher), Hastings and St. Leonards (Bloomfield), Abbotts Wood, Chailey and Tilgate Forest (Vine). Westmorland: Windermere (Threlfall). Wicklow: Powerscourt (Barrett), Wicklow Mountains (Birchall). Yorkshire: Scarborough (Stainton), Doncaster (Warren), Huddersfield (Inchbald), Mickley, near Ripon (Porritt), Richmond (Sang), Wheatley Wood and Cusworth (Corbett), Bingley (Butterfield). Orkney Islands: (McArthur).

Distribution.—Linné gives Sweden. Zeller says (*Linn. Ent.*, v., p. 324): *Calthella* occurs everywhere in Europe—in Italy and Sicily, at Syracuse (var. *b*); in Tuscany, near Pisa (Mann); in France (Duponchel); in England (Stainton); Sweden, as far as Lapland (Zetterstedt); in Finland (Tengström); in Volga District, Kasan (Eversmann); Silesia, at Ratisbon (Zeller); Higher Swiss Alps (Frey). Staudinger and Wocke give: Central and Northern Europe (except Polar regions); Dalmatia; Central and Northern Italy; Sicily and Corsica. Meyrick writes: Britain, extending to Sutherland; North and East Ireland (very common); Europe (except the south-west).

Stainton mentions: Belgium, in the Forest of Soignies to the south of Brussels. Snellen gives Holland—at Arnhem, Rotterdam, Maastricht, nr. Breda, etc. Frey mentions Zürich, Lausanne, and the Swiss Alps. Of its occurrence in the Higher Alps, he says: "Da *M. calthella* weit nordwärts verbreitet ist, so erscheint sie demgemäss auch auf den Alpen; wenigstens trafen wir sie Anfang August auf den Glarnerbergen, z. B. Mühlebachalp, in ungefährer Höhe von 5000′, ebenso im Engadin bei Samaden" (*Die Tineen*, etc., p. 48). Schiffermüller gives Austria; Schrank—Bavaria; Turati—Lombardy; Mann—Corsica, Sicily, Croatia (Fiume), and Roumania (Dobrudscha); B.-Haas—Denmark; Sand—France (Indre); Walsingham found the insect at Rome, April 10th-25th, 1893; Wallengren gives Southern Norway, Denmark and Sweden (Scania, Blekingra, Smolandia, Bahusia, Vestrogothia, Ostrogothia and Lapponia); Nolcken notes Russia (Kokenhausen, Groesen, Cremon, Oesel Island, Riga and St. Petersburg). It is also recorded from almost all the German provinces, Sorhagen gives Grunewald, Finkenkrug, Havelland, Hamburg, etc.

M. ARUNCELLA, Scop. and M. SEPPELLA, Fab.

Considerable doubt exists as to whether we have under the names of *M. aruncella* and *M. seppella*, two, or one, species. Stainton, after having compared *aruncella*, sent to him by Zeller, with British *seppella*, says ("Monograph," etc., *Trans. Ent. Soc. Lond.*, 1850, p. 40): "The best character by which to distinguish the male of *aruncella*, from the male of *seppella*, is the position and form of the fascia; it is more slender, straighter, and placed nearer the base than in *seppella*. The entire absence of the silvery spot on the costa towards the apex, would appear at first sight to be a more decided character, but it is often no easy matter to see this spot in set specimens of *seppella*, and the latter is sometimes without it. I, last week (June 1850), took a specimen of *seppella*, entirely destitute of this spot, and which I was, therefore, inclined to take for *aruncella*. The anterior wings of *seppella* ♂ are narrower and greener than those of *aruncella* ♂. I am not at present aware of any character by which to separate the females of the two species." If we refer to the original descriptions, we find that the species (described independently) were not founded on the characters here pointed out by Stainton, but on the number of the pale fasciæ crossing the fore-wings, Scopoli's *M. aruncella* having but one fascia, the *M. seppella* of Fabricius, two. The latter described *M. seppella* from a British specimen, which he saw in the possession of Mr. Yeats, so that we know that *M. seppella* is a British species. Zeller seems to have been the first entomologist who refused to see in *M. seppella*, Fab., a species distinct from *M. aruncella*, Scop., and Snellen also united the insects, treating *M. aruncella* as the type and *M. seppella* as an aberration. Meyrick has since followed these authors. Referring the matter to Lord Walsingham, who has a long continental series (including Zeller's), he writes: "I am able to find but one species under the two names, *seppella*, Fab. and *aruncella*, Scop. They vary in the direction of the central fascia, in the presence or absence of a costal spot, and in the degree of development or distinctness of the basal streak or fascia. There is no specimen in the somewhat extensive series that I have examined which can be said to have no markings beyond one fascia. If such a species exists it was evidently unknown to Zeller, and I am not disposed to accept Scopoli's precise language as proving the existence of such a species, therefore, I should write *aruncella*, Scopoli = *seppella*, Fab. An examination of the genitalia supports the view that British *M. aruncella* and British *M. seppella* are the same species, and I am unable to find any evidence to the contrary among the continental forms" (*in litt.*, April 3rd, 1898). We have since examined Constant's collection and are quite unable to separate his *M. aruncella* from "Burgundy, Würtemburg and Prussia," from his *M. seppella*, also from "Burgundy," and we are inclined to think not only that all so-called British *M. aruncella* are but forms of *M. seppella*, but that the Carniolian *M. aruncella* is identical with the British *M. seppella*. We have, however, nothing but negative proof that the unifasciate *M. aruncella* is the same as the bifasciate *M. seppella*.

Another doubtful point connected with these species relates to the possibility of *eximiella*, Zell., being synonymous with *seppella*, Fab. Stainton, in 1850, by comparison of actual specimens, states (*Monograph*, etc., pp. 39-40) that his *aruncella* of p. 29 (=*seppella*) is the *eximiella* of Zeller (*Stett. Ent. Zeit.*, 1850, p. 62). Zeller, in 1851, refers (*Linn. Entom.*, v., p. 327) Stainton's *seppella* of the *Monograph*, pp. 39-40, to his *aruncella*, allowing *eximiella* to rank as a distinct species. The original specimens of the latter were taken in Italy by Mann, and are now in Lord Walsingham's possession. The latter writes: "Zeller seems to have been inclined to sink it, but Mann's specimens, on which it was founded, have a very distinct spot beyond the fasciæ, which are themselves remarkably evident; moreover, the spot seems to be invariably oblique and inverted. I have a male from Rome possessing the same characters, also three males which I collected in Corfu in 1872, and I think that it will be found that the southern form is worthy to retain the special name *eximiella*, Zell. Zeller had placed his *eximiella* with a block of specimens consisting entirely of *M. seppella*, sent by Stainton, in close juxtaposition with *aruncella*, and he labelled one of Stainton's specimens '*seppella*=*eximiella*.' I am, therefore, unable to account for his having referred *seppella*, Stn., to *aruncella* (*Linn. Entom.*, v., p. 327), unless it can be interpreted as an admission that he was unable to separate the species, which is more than probable" (*in litt.*, April 3rd, 1898).

Snellen works out the species (or forms) as follows:—

1. *Aruncella*, Scop. = the type form.
    var. i.—*Seppella*, Fab.—With the addition of a silver spot towards the apex.
    var. ii.—*Eximiella*, Zell.—With the central line curved, and the spot at the base decidedly lengthened.

It has been considered advisable, after having reviewed the main evidence relative to *M. aruncella* and *M. seppella* being the same species, to work out their synonymy, etc., separately, so that further workers may not be confused by our adopting the simple expedient of lumping them.

MICROPTERYX ARUNCELLA, Scop.

SYNONYMY.—Species: *Aruncella*, Scop., "Ent. Carn.," No. 660, p. 254 (1763); Zell., "Isis," 1839, 185; "Linn. Ent.," v., p. 325; Sta., "Mon., Trans. Ent. Soc. Lond.," 1850, 39 (*nec* p. 29 and Pl. iii., figs. 5 ♂—6 ♀); "Ins. Brit.," 43; "Man.," ii., p. 302; H.-Sch., "Sys. Bear.," v., p. 391, no. 2; Frey, "Die Tineen," etc., 48; Stdgr. and Wocke, "Cat.," p. 340; Heinemann and Wocke, "Schmett. Deutsch.," p. 772; Snellen, "Vlinders," etc., p. 1066; Herklots, "Bouwstoffen Fauna Ned.," etc., iii., p. 216; Meyrick, "Handbook," etc., 806. *Concinnella* ♂, Stephs., "Illus.," iv., p. 361.

ORIGINAL DESCRIPTION.—Long. lin. 1¼. Alæ anticæ auratæ, cum intermixto violaceo-rubro colore; fronte aureis pilis pubescente. Antennæ nigricantes. Mas fascia pallida lineari; fæmina absque alarum fascia. Copiosa in paniculis *Acteae*, *Arunci* (Scopoli, *Ent. Carniolica*, No. 660, p. 254).

IMAGO.—Fore-wings 6½-8 mm.; golden-brown, with the costa at the base purple; in the ♂ a straight, slender, silvery fascia in the centre of the wing and a small silvery spot near the base. Posterior wings grey, the apical portion tinted with purple.

SEXUAL DIMORPHISM.—The anterior wings of the female are golden-brown in colour, with the costa, at the base, purple, and entirely destitute of the silvery markings of the male.

NOTES ON SO-CALLED BRITISH M. ARUNCELLA.—We have already pointed out (*ante*, p. 145) that Stainton, on comparing Continental specimens of *M. aruncella* from Zeller, found them to differ from his own British series of *M. seppella*. We are not disposed to think that these differences are of specific value, more especially as Stainton refers specimens captured at Darenth Wood, Sydenham and Penge, to *M. aruncella*. Our opinion that the British specimens passing as *M. aruncella* are co-specific with *M. seppella* receives confirmation from various lepidopterists. Meyrick says: "The variety of the male with a posterior costal mark, has long been regarded as a distinct species under the name of *M. seppella*, but the two forms are connected by gradual transitions" (*Handbook*, etc., p. 806). Atmore writes: "I have long regarded *M. seppella*, and the so-called British *M. aruncella*, as one species. The specimens appear to occur in forms which are difficult to refer to either the one or the other" (*in litt.*). Bankes says: "The specimens standing in my collection under the name *M. aruncella* were taken in company with typical *M. seppella*, and are, I have no doubt only forms of that species, differing from the type in the absence of the silvery spot near the apex, and, in some cases, in the silvery fascia near the base being reduced to a spot or inconspicuous, but the median fascia is quite as oblique as in any *M. seppella*." On the other side, Hamm says: "*M. seppella* is fairly abundant in the Reading district (parts of the counties of Berks, Hants and Oxon), but *M. aruncella* only occurs very sparingly, not more than two or three in a season. These, however, are taken in a similar manner, and at about the same time of year as the commoner species" (*in litt.*). As Zeller, throughout his writings, unites *M. aruncella* and *M. seppella*, and gives characters common to both, his descriptions do not help us much. He diagnoses (*Linn. Entom.*, v., p. 325) two forms, of which the first may be *M. aruncella*, and the second, *M. seppella* (unless, indeed, the reference to the transverse spot before, and the straight striga beyond, the middle, makes both referable to the latter), as follows:—

a.—Capillis ferrugineis; alis ant. virescenti-aureis basi ad costam purpurea: ♂ (post-mortem sulcato), macula transversali ante, striga recta post medium argenteis, ♀ unicoloribus.

b.—♂, gutta costali ante apicem argentea.

None of these notes help much the question of whether we have two distinct species, the unifasciate *aruncella*, Scop., and the bifasciate *seppella*, Fab. They do show pretty clearly that so-called British *M. aruncella* are co-specific with *M. seppella*. Meyrick, after sinking

M. seppella as synonymous with *M. aruncella*, describes only the latter form with the straight median fascia, so that anyone taking the common form—*seppella*—with the oblique (or slightly curved) median fascia would be puzzled where to place it.

Variation.—Frey refers [*Lep. der Schweiz*, 426 (1880)], to a form that he calls *M. aruncella*, Sc. var. *atricapilla*, Wocke, as coming from the Stelvio. Stainton calls attention to the fact that the reddish hairs on the head of the male are very easily rubbed off in all the allied species. Durrant believes *atricapilla* to be a distinct species. He writes: "The specimens from Wocke in the Zeller collection are certainly not worn, and the head is as black as that of *M. mansuetella*. These specimens were taken July 14th-15th, 1875. Zeller put the specimens at the end of his series of *M. calthella*, in line by themselves, before his var. *b*" (*in litt.*, May 21st, 1898).

Habitat.—Barrett says that at Haslemere he has found *M. aruncella* in marshy places, in the early part of July, running over the leaves of *Epilobium angustifolium*, and also in hedges among beech bushes. Scopoli found imagines on the flowers of *Actaea* and *Spiraea aruncus*; Schmidt, on the blossoms of *Helianthemum alpinum*; Schläger, on flowers of *Acer campestre*; Zeller also gives *Spiraea aruncus*, and adds the blossoms of *Pyrola minor* and *Plantago media*, as being attractive to this species. Frey connects it with *Scabiosa*. South records it as being obtained in North Devon by sweeping mixed herbage, whilst in Stainton's collection at the British Museum, are 4 specimens labelled as having been taken at "light."

Time of appearance.—Stainton gives June for England, and Schmidt mentions August for the Alps; Schläger gives the end of May and beginning of June at Jena, and Treitschke, June for Vienna. Zeller gives the commencement of July at Reinerz, Barrett giving the same time at Haslemere, and Wheeler records it as occurring at Rannoch in July, 1876. Common on July 8th, 1870, at Macugnaga, a village at the head of the Val d'Anzasca, at the east base of Monte Rosa (Staudinger). Frey says that in the Swiss Alps the species occurs in July and August. This would appear to be rather later in its appearance than most of the other species of this group.

Localities.—The reputed British localities for *M. aruncella* are as follows:—

Berks: Wokingham (Hamm). Cheshire: Dunham Park and Knutsford (Chappell). Devon: North Devon (South). Gloucester: Bristol (Stainton) Hants: Basingstoke (Hamm). Kent: Tenterden and Pembury (Stainton), Darenth Wood (Stephens), between Sydenham and Penge (*ante* 1850, Thomson). Lancashire: Manchester (Stainton). Norfolk: Brooke Woods (Barrett). Perth: Rannoch (Wheeler). Surrey: Haslemere (Barrett). Wilts: Marlborough (Meyrick).

Distribution.—Wocke separates *M. aruncella* from *M. seppella*, and gives: South-west Russia and Central Europe. Staudinger found it abundant at Macugnaga (on the east base of Monte Rosa). Scopoli recorded the original specimens from Krain (Carniola), whilst Frey and Schmidt both record it from the Swiss Alps. Treitschke gives Vienna, and Fischer von Röslerstamm, Bohemia, whilst Schläger mentions Jena, and Standfuss the Silesian mountains (*e.g.*, the Probsthainer summit). Zeller notices it as occurring at Reinerz, near Glogau and Schalten; Snellen gives Holland, near Rotterdam. Frey also records it from Zürich and Lausanne. Of its occurrence in the Swiss Alps, Frey writes: "Ich traf sie auf den Glarner Alpen in Höhen über 5,000′ (Bergli- und Mühlebachalp), in noch bedeutenderer Elevation auf denjenigen des Engadin, so Alp Murailg und der Celeriner Alp bei Samaden bis gegen 7,000′ " (*Die Tineen*, etc., pp. 48-49). Constant possesses it from Burgundy, Würtemburg and Prussia. It has also been recorded from Anhalt, Frankfort, Galicia, Nassau, Croatia, Tyrol, Carinthia, Hamburg and Brandenburg; Liguria, Piedmont and Lombardy; Saone-et-Loire, Indre; Riga, St. Petersburg; Scania, Bahusia, Ostrogothia; Attica.

MICROPTERYX SEPPELLA, Fab. (? var. praec. sp.).

SYNONYMY.—Species: *Seppella*, Fab., "Gen. Ins.," p. 296 (1777); "Ent. Syst.," 3, 2, p. 320, No. 144; Haw., "Lep. Brit.," ♂, p. 573; Stphs., "Illus.," iv., p. 362; Wood, "Index," 1601; Stainton, "Mon.," p. 39; "Ins. Brit.," p. 43; "Man.," ii., p. 303; H.-Sch., "Sys. Bear.," v., p. 391; Stdgr. and Wocke, "Cat.," p. 340. *Podevinella*, Tr., "Die Schmett.," ix., 2, 119*; Dup., "Hist. Nat.," xi., pl. 302, fig. 5, p. 399; ? Hb., "Samm. Eur.," 342. ? *Eximiella*, Zell., "Stett. Ent. Zeit.," 1850, p. 62; "Linn. Ent.," v., p. 328. *Aruncella*, Sta., "Cat. Tin.," p. 9; "Trans. Ent. Soc. Lond.," 1850, pp. 29-30, Pl. iii., fig. 5, (corrected) *Ibid.*, p. 39; Snellen, "Vlinders," etc., p, 1066 (in part); Meyrick, "Handbook," etc., p. 806 (in part). *Calthella*, Haw., "Lep. Brit.," iv. (β. ♀ = *seppella*), p. 573; ♀, Bentley, "Zool.," vol. iii., 1086.

ORIGINAL DESCRIPTION.—*Tinea* alis auratis: strigis duabus argenteis. Minuta. Corpus nigrum antennis brevibus. Alæ anticæ auratæ, nitidæ strigis duabus rectis argenteis. Posticæ auro nitidæ. Habitat in Anglia. Dom. Yeats (Fabricius, *Genera Insectorum*, p. 296).

[There can be no doubt about this species being British, and until it has been proved that the British bifasciate *seppella* = the Carniolian unifasciate *aruncella*, the species should stand].

IMAGO.—Fore-wings 7-8 mm.; shiny, golden green, with the base of the costa purple; in the ♂ with two, pale, silvery fasciæ, one in the middle of the wing, the other nearer the base, there is also a pale silvery spot towards the apex, and not far from the costa. Hind-wings grey, with the apical half tinged with purplish.

SEXUAL DIMORPHISM.—The anterior wings of the female are golden-brown, the costa at the base purplish, and with none of the pale markings that distinguish the male. The female much resembles *M. calthella*, but, independently of the wings not being sulcate, as in the latter, the base of the anterior wings is never purple to the inner margin as in that species, but only a little way from the costa.

COMPARISON OF ♂ M. SEPPELLA WITH ♂ M. ARUNCELLA.—Stainton, who received specimens from Zeller, which the latter considered to be *M. aruncella* (*vide*, *Monograph*, etc., p. 40), says that the anterior wings of *M. seppella* ♂ are narrower and greener than those of *M. aruncella* ♂. This is a structural character, apart from the fact that *M. aruncella* is an unifasciate, and *M. seppella* a bifasciate, species.

VARIATION.—There is some variation in the basal fascia and outer costal spot. Richardson says: "The costal mark near the apex of the fore-wing is distinctly traceable in all my male specimens, though it varies somewhat in intensity" (*in litt.*). By Stainton, the basal fascia is described as a transverse silvery spot which reaches neither margin. He also states that it is often no easy matter to see the silvery spot on the costa towards the apex in some specimens, and he took a specimen entirely destitute of it. Bankes says: "Forms of that species (*seppella*) differ from the type in the absence of the silvery spot near the apex, and, in some cases, in the silvery fascia near the base being reduced to a spot or inconspicuous" (*in litt.*).

---

* Stainton says: "*Podevinella*, Tr., which Zeller gives as a synonym of *aruncella* is most certainly *seppella*."

a. ? var. *eximiella*, Zell.—We have already pointed out that there is some doubt as to whether Zeller's *eximiella* is not a southern form of this species. It was described in a "List of the Tuscan Lepidoptera observed by Herr J. Mann" [*Stett. Ent. Zeit.*, xi., p. 62 (1850)] as follows: "*Micr. eximiella*, Koll. nov. sp.—Am 24 April bei Montenero, wo sie in den Mittagstunden im Sonnenschein um Myrthenstraüchern schwärmte. *Micropteryx eximiella*: capillis ferrugineis; alis ant. viridi-aureis, strigis duabus maculaque costæ postica niveis (mas). Size of *Micr. aruncella*, to which the species stands nearest, but the wings are still narrower. Head hairy, rust-coloured. Antennæ brown, finely serrated. Thorax shining gold colour. Abdomen brown. Legs glossy, brownish-yellow. Fore-wings greenish-gold, glossy, violet at the base, very narrowly reddish on the costa, more coppery at the apex. At the beginning of the second fifth is a thin, snow-white, almost perpendicular transverse line; in the middle of the wing, one similarly formed, only somewhat convex externally; in the middle, between it and the apex, a snow-white spot, broadened and rounded below, hangs on the costa. One example (var. *b*: puncto costali niveo ante maculam posticam) has, immediately before this, a little snow-white marginal dot. The apex is more "wrinkled" than the rest of the surface. Fringes exteriorly grey. The grey-fringed hind-wings are "furrowed," and of a somewhat shining light copper-colour. The whole underside is like the upperside of the hind-wings, but brighter on the fore-wings; here the central line shows through very obscurely. The ♀, probably, as in *aruncella*, very differently marked, is unknown to me." This description agrees very well with our British *M. seppella*, and the similarity is further accentuated in the *Linn. Ent.*, v., p. 328, where Zeller says that *M. eximiella* is of the size of *M. aruncella*, but differs from the latter (1) in the extension of the basal transverse spot into a transverse line, (2) in the external convex curve of the central line, (3) in the lengthening of the costal spot, which is broadened and rounded off below, and (4) by the somewhat more extended fore-wings." Lord Walsingham's remarks on the specimens have already been quoted (*ante*, p. 146). In note 3 (*l.c.*, p. 327), Zeller draws attention to the fact that Stephens mentions the occurrence of the costal spot in *concinnella*, and suggests that both Stainton's *aruncella* and *seppella*, and Stephens' *concinnella* and *seppella*, are but one species. Stainton states most distinctly (*Monograph*, etc., p. 40) that he received from Zeller "specimens of *seppella* as *eximiella*" and this may be taken by many entomologists as conclusive evidence of their specific identity, although there appears to be no evidence to show that the *eximiella* received by Stainton from Zeller were any of the original specimens taken by Mann at Montenero.

Ovum.—The ovum is spherical, 0·41 mm. in diameter, *i.e.*, slightly smaller than that of *M. calthella*, and distinctly yellow; otherwise it is much like that of the latter species (Chapman).

Habitat.—This species is found in a variety of situations—downs, woods, etc.—but appears to be especially partial in the imago state to the flowers of *Veronica chamaedrys*. Bower has found it flying in the morning sun, at rest on grass blooms and those of *Veronica*, and also obtained specimens by beating in various parts of Kent and Surrey. Atmore has observed it on flowers of *Veronica chamaedrys*, from which it is readily swept; it flies only in sunshine. Richardson says that it is common at Portland among mixed herbage. At Wareham, Cambridge says that it is abundant in all kinds of situations, and to be obtained by sweeping. Corbett says that *M. seppella* seems to prefer drier places than those inhabited by *M. calthella*. It frequents flowers of *V. chamaedrys*, *Mercurialis perennis*, *Galium saxatile*, *Nepeta glechoma*, etc. The imagines are not so conspicuous as those of *M. calthella*, due, perhaps, to the fact that the flowers they frequent are smaller and more numerous, so that one single flower does not harbour so many moths; the moths are generally taken by sweeping, and occur at about the same time as *M. calthella*. Stainton says that it is a common species, that he found it in abundance in a wood near Ambleside, and in a lane near Coniston, in June, 1846, and on a grassy bank, near Carron, in 1874, when several pairs were captured *in copulâ*. Hamm takes it commonly in damp places throughout the Reading district, comprising parts of the counties of Berks, Hants, and Oxon, by brushing lightly among the long grass. South found it in North Devon, resting in flowers of *V. chamaedrys*, on sunny banks, often several females in a flower, the male very rarely met with.

Time of appearance.—This species is on the wing throughout June. In the Reading district, June 6th is a fair average date (Hamm). The following are recorded dates :—

July 6th, 1858, at Flamborough Head (Horton); June 2nd, 1850, at West Wickham; June 4th, 1849, at Carron; June 5th, 1850, at Sanderstead; June 11th, 1850, at Sanderstead; June 23rd, 1853, at Lewisham; July 7th-10th, 1879, at the Bridge of Allan (Stainton); June 13th, 1887, June 16th, 1891, May 25th, 1893, June 6th, 1895, at Greenhithe; June 18th, 1892, at Eltham; June 24th, 1892, at Sanderstead; June 19th, 1893, at Chattenden; June 28th, 1894, near Farningham; June 18th, 1895, at Bexley (Bower); May 27th, 1890, at Ashtead (Cansdale); June 19th, 1853, at Castle Eden Dene (Sang); occurs rather later in the year than *E. calthella*, sometimes at end of May, but generally during June, and even as late as beginning of July, common June 28th, 1897 (Atmore); June 29th-July 8th, 1887, July 10th, 1888, at Portland, and July 7th-9th, 1891, in Bloxworth Woods (Richardson); June 4th, 1893, at Chippenham Fen; June 21st, 1893, roadsides near Cambridge (Farren); June 9th-14th, 1881, June 16th-30th, 1882, June 7th-18th, 1883, June 15th-24th, 1884, June 6th-26th, 1885, June 15th-28th, 1887, June 16th-July 2nd, 1888, June 12th-24th, 1889, June 13th-26th, 1890, June 15th-30th, 1891, June 13th-28th, 1892, June 11th-25th, 1893, June 14th-29th, 1894, June 16th-27th, 1895, June 12th-27th, 1896, June 15th-28th, 1897, at King's Lynn (E. A. Atmore); June 12th, 1889, near Doncaster; June 22nd, 1893, at Wheatley Woods (Corbett); June 16th, 1877, at Windermere (Threlfall); May 30th, 1883, two specimens, *ex larvâ*, ♂ and ♀, then supposed to have been bred from *Carex*, emerged at Merton (Walsingham); March 25th, 1888, at Merton (Durrant).

Localities.—Aberdeen: Pitcaple (Reid). Berks: Reading (Hamm), Bulmershe (Holland). Cambridge: Cambridge and Chippenham Fen (Farren). Cheshire: Birkenhead (Stainton), Bidston and Tranmere (Brockholes), New Brighton (Gregson), Knutsford (Chappell). Cumberland: Lake District (Stainton). Derby: Henhurst (Brown). Devon: Chudleigh (Stainton), North Devon (South). Dorset: Portland, Bloxworth (Richardson), Purbeck (Bankes), Wareham (Cambridge). Durham: Darlington (Stainton), Castle Eden Dene (Sang), Hesleden Dene (Gardner). Edinburgh: Edinburgh district, abundant (Evans). Gloucester: Bristol (Stainton), Leigh Woods (Mason). Hants: Brockenhurst (Farren), north part of county (Hamm). Hereford: Tarrington (Wood), Leominster (Hutchinson). Kent: Lewisham and West Wickham (Stainton), Greenhithe, Eltham, Chattenden, near Farningham and Bexley (Bower). Lancashire: Manchester and Coniston (Stainton), Grange and Preston (Threlfall). Leicester: Market Harboro' (Matthews). Norfolk: King's Lynn (Atmore), Merton (Walsingham), Norwich (Barrett). Northumberland: Newcastle (Stainton). Oxon: Hardwick (Holland), part of county in Reading district (Hamm). Somerset: Castle Cary (Macmillan), Clevedon (Mason). Stirlingshire: Carron and Bridge of Allan (Stainton). Suffolk: Tuddenham (Warren). Surrey: Coombe Wood (Curtis), Haslemere (Barrett), Ashtead (Cansdale), Sanderstead (Bower). Sussex: Common in the county (Fletcher), Lewes (Stainton), Cissbury and Clapham Woods (Fletcher), Hastings and St. Leonards (Bloomfield), Abbotts Wood, Chailey, Brighton Downs (Vine). Westmorland: Ambleside (Stainton), Windermere (Threlfall). Wicklow: Wicklow (Birchall). Wilts: Marlborough (Meyrick). Yorkshire: York and Scarborough (Stainton), Flamborough Head (Horton), Huddersfield (Porritt), Wheatley Wood and Sprotboro' Woods, near Doncaster (Corbett).

Distribution.—*M. seppella* is generally distributed in England, and extends into Scotland as far north as Aberdeenshire. It is of general occurrence in Ireland (Birchall). It is so mixed up with *M. aruncella* on the continent that its range is practically unknown. Staudinger and Wocke give :

England, France and Italy. Stainton's collection contains specimens labelled "N. Germany," and others from Glogau, in Silesia. Stainton records it from the Forest of Soignies, nr. Brussels. Constant has specimens from Burgundy. Mann notices it from Sicily; Curò from Tuscany. It is also recorded from France: Saone-et-Loire, Indre; Germany: Brandenburg, at Havelland and Pomerania.

MICROPTERYX MANSUETELLA, Zell.

Synonymy.—Species: *Mansuetella*, Zell., "Bericht des Schles. Tausch.-Vereins," v., p. 16 (1844); "Linn. Ent.," v., p. 337 (1851); Sta., "Monog.," p. 33, fig. 6 (1850); "Ins. Brit.," p. 43; "Man.," ii., p. 303; H.-Sch., "Sys. Bear.," v., p. 391 (1856); De Graaf, "Tijds. v. Ent.," 1870, p. 220; Stdgr. and Wocke "Cat.," p. 340 (1871); Wocke, in Hein., "Schmett. Deutsch.," p. 775 (1876); Snellen, "Vlinders," etc., p. 1067; Meyrick, "Handbook," etc., p. 806. *Ammanella*, Wood (*nec* Hb.), "Index," p. 231, no. 1602, pl. 50 (1839) (name preoccupied).

Original description.—Aehnlich und so gross wie *calthella*, schwarzköpfig, mit verloschenen hellen Binden auf der Vorderflügeln, bei Glogau in einen Erlenbruche zu gleicher Zeit mit *calthella* auf Blüthen von *Sorbus aucupariae* in Menge, seltener an *Spiraea ulmaria* u. Rietgrasblüthen (Zeller, *Bericht des Schles. Tausch.-Vereins*, v., p. 16). In 1851, Zeller gives the following diagnosis: "Capillis atris; alis anterioribus nitidis aureo-purpureis, fasciis duabus, altera prope basin, altera media, obsolete aureis" (*Linn. Ent.*, v., p. 337). To which, after a reference to his former note in the *Schles. Schmett.*, he adds Stainton's diagnosis: "Capillis atris; alis anticis aureo-viridibus, macula basale ad costam, fascia ante medium, apiceque, rufescentibus, obsoletis" (*Monograph*, p. 33, fig. 6). [One might suppose from these descriptions that Zeller and Stainton were describing two different species, but whilst one has taken the golden-purple tint as the ground-colour, the other has taken the golden-green, and described the purple markings as reddish. Their insects are identical.]

Imago.—Head black (that of other species reddish or yellowish). Fore-wings 8-9 mm.; shiny, light golden green, with the base, a transverse fascia before the middle, and the apex of the wing, purplish. Hind-wings dark grey, apex purplish; cilia ashy.

Comparison between M. mansuetella and M. thunbergella.—Stainton writes: *M. mansuetella* is readily distinguished from every other known British species of the genus by its deep black head; but, independently of this character, it may be recognised by being of the size of *M. calthella*, with the markings on the anterior wings somewhat resembling those of *M. thunbergella*, only more indistinct.

Habitat.—Healy, early in May, 1861, observed the imagines of this species in numbers flying over and settling upon plants of *Mercurialis perennis*, and although driven away by his hand, they quickly returned. Barrett records it as swarming in a damp place by the railway embankment at Haslemere, on the blossoms of *Luzula pilosa*, in company with *M. calthella*, and writes: "At a short distance from Haslemere, there is a swampy copse, consisting principally of alder, sallow and birch bushes, with plenty of bramble, rushes, and high tussocks of sedge, and cut up in every direction with drains. Here, on May 18th, 1866, I found *M. mansuetella* and *M. allionella* pretty commonly, with *M. calthella* in abundance, all flitting among and settling upon the rushes and culms of sedge, keeping generally in the shadow of the high bushes, not in the sunshine. At the end of the month, these species were found settling upon the sedge blossoms, where they were joined by *M. thunbergella*." Hodgkinson notices it as occurring about streams, and in swampy places, at Windermere; whilst Threlfall says that in the latter district it is local, but very abundant where it occurs. Near Grantham it is particularly attached to flowers of *Mercurialis perennis*, and to those of *Carex* in woods, and flies in sunshine (W. A. Atmore). Abundant in blossoms of king's-cup (*Caltha palustris*) in May, and may be obtained by sweeping other herbage, but always in swampy places, about Bloxworth (Cambridge). Zeller writes: "I discovered this species in a boggy alder swamp in the woods, near Glogau, among low bushes, settling on the *Carex* blooms in company with *M. calthella*. After that I found it on the flowers of the *Sorbus* bushes, whether growing in the open or surrounded by other trees. The insects seek their favourite flowers, often 10 or 12 feet above the ground, from which it is difficult to dislodge them. If disturbed, they conceal themselves among the blossoms, or creep under the leaves. On some of the umbels a large number were found, and when the bushes were shaken, some were afterwards discovered resting on the grass below." Bankes says that it is found commonly in some wet and mossy spots in woods and coppices near Bloxworth.

Time of appearance.—Gregson obtained this species, by sweeping, at Windermere, towards the end of May, 1870. Healy obtained it in early May, 1861. Eaton captured it on June 11th, 1880, in Portugal, by the streamlet near Cea. Stainton gives the end of May and June as its time of appearance. Other recorded dates are:—

May 18th-31st, 1866, at Haslemere (Barrett); June 15th, 1857, at West Wickham (Stainton); May 28th, 1887, near Grantham (W. A. Atmore); May 5th, 1890, May 1st-18th, 1892, very abundant at Bloxworth (Cambridge); May 22nd, 1896, at Aberfoyle (Evans); June 6th, 1876, June 16th, 1877, May 29th, 1878, at Windermere (Threlfall); May 22nd-25th, 1888, June 2nd, 1891, May 28th, 1898, abundant, at Merton (Durrant); May 22nd, 1850 and May 20th-25th, 1851, at Glogau (Zeller, *teste* Durrant).

Localities.—Cambridge: Cambridge Fens (Warren). Cumberland: Lake District (Stainton). Dorset: Bloxworth, very abundant (Cambridge), Glanvilles Wootton (Bankes). Gloucester: (Stainton). Hereford: Tarrington (Wood). Kent: Pembury and West Wickham (Stainton). Lancashire: Manchester (Stainton). Lincolnshire: Grantham (W. A. Atmore). Norfolk: Norwich (Barrett), Merton, Ranworth (Atmore). Perthshire: Aberfoyle (Evans). Suffolk: Stowmarket (Stainton). Surrey: Haslemere (Barrett). Sussex: Abbotts Wood (Vine). Westmorland: Braithwaite, Windermere (Gregson). Yorkshire: York (Stainton).

Distribution.—Zeller gives Glogau and the Silesian mountains (near Warmbrunn). Snellen records it from Holland, near Arnhem; Stainton received specimens from Staudinger labelled "N. Germany," and Constant has others from Bavaria; Staudinger and Wocke give Silesia. Meyrick writes: England (local), Germany. Eaton adds: Portugal (*teste* Stainton, *E.M.M.*, xvii., 246). Other records are Germany: Würtemburg (Hoffmann), Landsberg, Friedland, Stettin, Hanover (Sorhagen), Prussia (Krause); Austria (Schleicher); South Norway (Wallengren).

MICROPTERYX THUNBERGELLA, Fab.

Synonymy.—Species: *Tunbergella* (rect. *Thunbergella*), Fab., "Mant.," ii., No. 131, p. 253 (1787); Sta., "Ins. Brit.," 44 (1854); "Man.," ii., p. 303; H.-Sch., "Sys. Bearb.," v., p. 392 (1856); Frey, "Die Tineen," etc., 49; Stdgr. and Wocke, "Cat.," p. 341; Wocke, in Hein., "Schmett. Deutsch.," p. 776; Snellen "Vlinders," etc., p. 1067; Meyrick, "Handbook, etc.," p. 806. *Rubrifasciella*, Haw., "Lep. Brit.," no. 41, 572 (1828); Sta., "Monog.," p. 32, fig. 9 (1850);

Zell., "Linn. Ent.," v., p. 334 (1851). *Anderschella*, Hb., "Samm.," pl. 51, 352 (1816) Tr., "Die Schmett.," ix., 2, 126 (1833); Dup.," Hist. Nat.," xi., p. 403 (1838); Zell., "Isis," 1839, p. 185. *Hellwigella*, Stphs., "Ill.," iv., 360 (1835); Wood, "Index," p. 231, no. 1597. *Depictella*, H-Sch., "Schmett. Eur. Micr.," pl. i., fig. 7 (1851). *Paykullella*, Thnb., "Diss. Ac. Upsal.," iii., 101 (1794).

Original description.—*Tinea* alis auratis, maculis fasciaque media purpureis. Parva. Corpus nigrum. Antennæ breves nigræ. Alæ anticæ aureæ, nitidæ. Maculæ duæ purpureæ ante medium ad marginem crassiorem. In medio fascia lata purpurea ad marginem crassiorem bifida, versus apicem denique adhuc macula purpurea. Alæ posticæ auratæ, immaculatæ. Habitat Kiliæ (Kiel), Dom. Daldorf (Fabricius, *Mantissa Insectorum*, No. 131, p. 253).

Imago.—Fore-wings 8-9 mm.; shiny, light golden-green, with red costal spot near the base, an oblique fascia before the middle, another beyond the middle forked on the costa and joined to a costal spot towards apex (the latter spot is sometimes absent). Hind-wings pale grey, with a purplish tint towards apex.

Variation.—Zeller describes (*Linn. Ent.*, v., p. 334) two forms of this species as follows:—

1.—Capillis ferrugineis; alis ant. saturate aureis nitidis, humero, macula transversa costæ prope basim maculaque maxima postica costam ter tangente purpureis = *rubrifasciella*, Haw. Haworth's original description reads as follows: "*Tinea rubrifasciella* (The red-barred Gold), alis aureis fasciis quatuor rubro-purpureis. Expansio alarum 4 lin. Alæ anticæ saturate aureæ metallicæ fasciis quatuor æquidistantibus rubro-purpureis; prima basi: secunda, aliquantulam arcuata ante, tertia pone medium et ad costam bifida; quarta limbi postici, juncta ad tertiam juxta marginem tenuiorem. Cilia fusca. Posticæ fusco-cupreæ, præcipue pone medium. Habitat in Cantio, at valde infrequens" [*Lep. Brit.*, No. 41., p. 572 (1828)].

2.—Macula postica in duas soluta, priore costam bis tangente.

Treitschke describes his *anderschella*, also considered a form of this species, as:—

3.—Alis anticis purpureis, maculis sæpius confluentibus aureis = *anderschella*, Tr.

One form given by Zeller as a var. of *M. aureatella* is referred here. This is:

f.—Ut *a* (= *allionella*, F.), sed macula postica ad marginem posticum usque producta = *paykullella*, Thunberg, described as "Alis purpureis, fasciis 3 aureis" (*Diss.*, iii., p. 101).

Habitat.—The habitats of this species vary exceedingly. In some places it abounds on the chalk-hills, as at Cuxton in Kent, in others it is equally abundant in fenny districts. In Bohemia it occurs on the sand-hills, and in Livonia, in the bushy districts on chalk-hills. Farren says that in Chippenham Fen, in 1891, the species was to be found swarming about the bird-cherry and fir-cones. (It was so abundant that he boxed fifteen specimens in one large chip-box, off a single cone.) He states that it is more abundant on a close, warm day, soon after noon; the firs on which this species was found were growing on the outside of a belt of trees in the Fen, the bird-cherry among the less thick parts of the ordinary fen growth. Hodgkinson reports it as swarming under the shade of a yew-tree, at Grange, in 1873; whilst, at the same place, Shuttleworth records it as flying in the partial shade afforded by beech and fir trees in 1882. Bower has found it flying in the afternoon sun, and has taken it by beating and searching fences and tree-trunks in various localities in Kent and Surrey. At Grantham, Atmore has obtained it by beating hawthorn, the moth resting on the blossoms and flying by day. Richardson says that the insect is common in many places on the downs near Worthing, flitting about near the ground. Cambridge notes it at Wareham, as being abundant on oak trees and underwood in May; and Butterfield as being common in Scotch fir woods at Wilsden. Holland notes that the species flies around birch, nut, and other trees, yet it appears to be always beneath or near oaks, and a sweep of the net will sometimes result in the capture of a score. Yet it can have no real connection with the oak, except for food or shelter. Farren notices it as resting on trunks of firs and oaks at Brockenhurst. South observes that in North Devon, on May 26th, 1882, he brushed the low branch of an oak-tree, in a small oak copse, and from it came quite a cloud of *M. thunbergella*. The insect, however, was on this day confined to the foliage of the tree first shaken, although at the end of the month, single specimens were beaten out of various trees and the undergrowth. Barrett says that at Haslemere it visits the sedge-blossoms with *M. calthella*, *M. mansuetella* and *M. allionella*. Vine beats it out of furze bushes (*Ulex europaeus*) about the second week of May, near Brighton, and Durrant sweeps it from young birch trees (? feeding on catkins), at Merton.

Time of appearance.—Usually this species is to be found in May and early June, and Madam Lienig gives the first days of May as the time of its appearance in Livonia. Other recorded dates are as follows:—

May 28th, 1850, at West Wickham; May 11th, 1852, at Dartford Heath (Stainton); May 20th, 1886, at Witherslack; May 31st, 1873, at Grange-over-Sands (Hodgkinson); May 13th, 1882, at Grange (Shuttleworth); June 15th, 1887, at Dartford Heath; May 16th, 1888, at Headley Lane; May 24th, 1888, June 5th, 1891, Greenhithe; May 28th, 1891, June 5th, 1894, April 30th and May 27th, 1897, at Bexley; June 14th, 1892, at Addington Park; April 18th, 1893 and May 10th, 1895, at Box Hill (Bower); June 4th, 1887, at Cuxton (Tutt); June 26th, 1853, June 8th, 1856, June 6th, 1857, June 7th, 1873, June 2nd, 1875, at Richmond, Yorks. (Sang); in May, at Grantham (W. A. Atmore); end of May and beginning of June, at Chippenham Fen (Farren); May 23rd, 1887, May 16th, 1889, near Arundel, (Fletcher); May 26th, 1882, in North Devon (South); end of May, 1866, at Haslemere (Barrett); May 25th, 1874 and May 26th, 1877, at Witherslack; May 14th, 1875, at Grange, and May 29th, 1878, at Windermere (Threlfall); May 20th, 1891, at Chingford, beaten from oak (Prout); May 26th, 1891, at Merton (Durrant); May 1st-3rd, 1898, at Oxton (Studd).

Localities.—Aberdeen: Pitcaple district (Reid). Berks: Reading (Hamm); Sulham, Tilehurst, Padworth and Aldermaston (Holland). Cambridge: Chippenham Fen (Farren). Cumberland: Lake District (Stainton). Derby: Henhurst (Brown). Devon: North Devon (South). Dorset: Kimpton (Curtis), Wareham (Cambridge), Bloxworth, Glanvilles Wootton and Purbeck (Bankes). Durham: Darlington (Stainton). Essex: Chingford (Prout). Gloucester: Bristol (Stainton). Hants: New Forest (Fletcher), Pamber Forest (Holland), Brockenhurst (Farren). Hereford: Tarrington (Wood). Kent: Cuxton (Tutt), West Wickham (Stainton), Dartford Heath, Greenhithe and Bexley (Bower). Lancashire: Manchester (Stainton), Croxteth Wood (Gregson), Grange (Threlfall). Leicester: Market Harborough (Matthews). Lincolnshire: Grantham (W. A. Atmore). Norfolk: Merton (Walsingham). Northumberland: Newcastle (Stainton). Somerset: Castle Cary (Macmillan), Brislington (Sircom), Clevedon district, abundant (Mason). Suffolk: Tuddenham (Warren). Surrey: Haslemere (Barrett), Headley Lane, Addington Park and Box Hill (Bower). Sussex: Thinly but widely distributed in the county (Fletcher), Lewes (Stainton), Goring Woods, Sompting (Fletcher), downs near Worthing (Richardson), Hastings and St. Leonards (Bloomfield), Moules Combe, near Brighton (Vine). Westmorland: Windermere and Witherslack (Threlfall). York: Richmond (Sang), York (Prest), Scarborough (Stainton), Huddersfield (Inchbald), Sedbergh (Warren).

Distribution.—Occurs in England and Scotland; in Austria and in

Bohemia (Treitschke); near Lauban, in Silesia (Wiesehütter); Livonia, in the Duna district (Lienig), Kiel (Fabricius); Forest of Soignies, Belgium (Stainton). Staudinger and Wocke give: Livonia, Galicia, Germany, Switzerland and England. Constant adds: Burgundy. Meyrick writes: England (in woods, common); Central Europe. The following is a more complete list: Austria: Bohemia (Treitschke), Vienna (H.-Schäffer), E. Galicia. Belgium: Soignies (Stainton). Denmark (B.-Haas). France: Saone-et-Loire (Constant), Cher and Indre (Sand). Germany: Landsberg, Brandenburg, Stettin, Hamburg (Sorhagen), Würtemberg (Hoffmann), Riesengebirge (Zeller), Strelitz, Ratisbon (H.-Schäffer), Nassau (Rössler), Thuringia (Knapp). Russia: Livonia, Duna dist. (Lienig), Bielsteinshof (Nolcken). Sweden: Vestrogothia (Thunberg), Scania, Bahusia (Wallengren). Switzerland: nr. Zürich (Frey), Lausanne (Laharpe), nr. Schüpfen (Rothenbach).

MICROPTERYX AUREATELLA, Scop.

SYNONYMY.—Species: *Aureatella*, Scop., "Ent. Carn.," pp. 254-255, no. 662 (1763); Göze, "Beitr.," iii. (4), 149, no. 192 (1783); Stdgr. and Wocke, "Cat.," p. 108 (1861); Const., "Cat. Lep.," p. 311, no. 1128 (1866); Stdgr. and Wocke, "Cat.," p. 340 (1871); Nlk., "Lp. Fn. Estl.," etc., pp. 495-7, no. 426 (1871); B.-Haas, "N.H. Tdsk.," x., 47 (1875); Wallengren, "Bih. Svensk. Vet.," etc., iii., 82, no. 430 (1875); Hein. and Wk., "Schmett. Deutsch.," 774, no. 6 (1876); Zell., "Stett. Ent. Zeit.," xxxix., pp. 161-2 (1878); Sand. "Cat. Lep. France," p. 203, no. 3099 (1879); Snellen, "Vlinders," etc., p. 1064 (1882); Curo, "Nat. Sic.," i., p. 89 (1882); Wallengren, "Ent. Tids.," 1883, 214; Sorhgn., "Kleinschm. M. Brandenbg.," p. 314 (1886); Meyr., "Handbook," etc. p. 806. *Allionella*, Fab., "Ent. Syst.," iii., pt. 2, p. 321, no. 148 (1794); Zell., "Isis," 1839, 185; Lienig, "Isis," 1846, p. 274; Tgström., "Not. Sällsk. Fn.," etc., i., 115 (1847); Sta., "Cat. Br. Tin.," p. 9 (1849); "Tr. Ent. Soc. Lond.," 1850, p. 31, pl. iii., fig. 7; Zell., "Stett. Ent. Zeit.," xi., p. 63 (1850); "Lin. Ent." (*vars. a* and *b* only), v., pp. 330-1 (1851); H.-Sch., "Schmett. Eur. Microp.," pl. i., fig. 6 (1851); Ghil., "Fn. Ent. Ital.," 78 (1852); Sta., "Ins. Br.," pp. 43-4 (1854); H.-Sch., "Schmett. Eur.," v., p. 392 (1856); Frey, "Die Tineen," etc., pp. 49-50 (1856); Sta., "Ent. Ann.," 1857, 123; "Man.," ii., p. 303 (1859); Frey, "Ent. Ann.," 1858, 142; Rösslr., "Jahrbuch Nassau," etc., xix.-xx., no. 1324 (1866); Sta., "Tin. S. Eur.," 56, no. 27, 91, 284 (1869); Sta., "Ent. Ann.," 1874, 6; Frey, "Lep. Schweiz," 427 (1880); Porritt, "List Yorks. Lep.," p. 137 (1883); Walter, "Jena Zts.," xviii., pp. 751-807 (1885). *Amoenella*, Stphs., "Cat. Br. Ins.," ii., p. 227, no. 7582 (1829). *Ammanella*, Curt., "Guide," 188, no. 1037, 19 (1831); Stphs., "Ill.," iv., p. 362 (1835); Zett., "Ins. Lapp.," p. 1008, no. 10 (1840); Koch, "Isis," 1848, 950; Hdnrch., "Lp. Eur. Cat.," p. 80, no. 139 (1851); Westwood and Humph., "Br. Moths" (2 Ed.), ii., p. 254 (1854). *Tricinctella*, Costa, "Fauna Napoli," p. 11, pl. ii., fig. 2 (1834). *Paykullella*, Werneburg, "Stett. Ent. Zeit.," xx., p. 67 (1859).

ORIGINAL DESCRIPTION.—Long. lin. $2\frac{1}{3}$. Alæ anticæ rubro-auratæ; fascia maculisque aureis. Macula aurea in limbo et alia ad basim, fascia intermedia. Caput rufis pilis pubescens. Oculi fusci. In sylvestris locis (Scopoli, *Ent. Carniolica*, pp. 254-255).

IMAGO.—Fore-wings 8-11 mm.; purple, with a pale golden fascia near the base, another in the middle, and a pale golden costal spot near the apex. Hind-wings pale ashy, with a purple tinge towards the apex.

VARIATION.—This species, so far as may be judged from purely British specimens, would be considered a constant species with two golden fasciæ, one basal, the other central, and a costal spot towards the apex. Continental specimens, however, are referred to this species, which frequently have an extra golden spot within the normal costal apical one, sometimes small, at other times much larger. There is also some slight difference in the direction of the central fascia, which is straighter in our British examples. Our own experience of the latter form was obtained at Cannes, on April 19th, 1898, when Dr. Chapman collected a long series. Examination of these, both alive and dead, tended to make us suppose that they represented a species distinct from the British examples. Lord Walsingham, however, refers them to *M. aureatella*, and writes : " I have examined very long series of this species, ranging from Cannes through Switzerland and the Tyrol to North England. Although at first sight the British specimens appear to be distinguishable, I find variations, especially among the Bergün examples, which seem to me to connect the two forms. Many of the foreign ones possess a strong golden-green suffusion about the termen (not on the dorsum), and the extra spot is usually (not always) present. Some British examples possess this extra spot, and some foreign specimens are without the terminal gloss. I am driven to the same conclusion as Snellen, that *M. aureatella*, which certainly occurs at Cannes (as entirely distinct from *M. ammanella* and *M. aglaella*) is inseparable from our British specimens known as *allionella*, Fab." He also adds : " *M. ammanella*, Hb. (=*anderschella*, H.-S. in error), is easily distinguished from *M. aureatella*, Scop., by the golden-green gloss on the dorsum from the base to the fascia, whilst *M. aglaella*, Dup., is a much smaller species." Meyrick notes (*Ent. Mo. Mag.*, vol. xxvii., p. 58) that this species is variable in Algeria, but it is possible that Meyrick is here referring to *M. algeriella*, Rag. Zeller gives (*Linn. Ent.*, v., p. 330) a table of six different forms which he refers to this species, of which, however, *d* and *e* are referred by Wocke to *M. anderschella* = *ammanella*, Hb. (*teste* Walsingham), and *a*, *b*, *c* to *M. aureatella*, but Durrant says that the type of var. *c* (in Lord Walsingham's collection) is a ♀ of *M. ammanella*. Zeller's diagnoses of the forms *a* and *b* read as follows :—

a.—Capillis ferrugineis, alis ant. violaceo-purpureis nitidis, fasciis duabus (altera basim versus, altera media) maculaque magna posticæ costæ adhærente aureis distinctissimis=*allionella*, Fab. (*Ent. Sys.*, 3, 2, p. 321); Zell. (*Linn. Ent.*, v., p. 330); *ammanella*, Hb., 358; Koch. (*Isis*, 1848, 950).

b.—Macula postica costam non attingente = *Adela ammanella*, Tr. (*Die Schmett.*, ix., pt. 2, p. 125); Zett. (*Ins. Lapp.*, 1008, 10); *Lampronia ammanella* (St., *Ill.*, iv., p. 361), etc.

Lord Walsingham, who has Zeller's insects, writes : " Zeller's type of *allionella (a)* stands in a block of 13 specimens. Of these, 9 are British *aureatella* received from Stainton. Specimen 10 from Tiedemann, specimen 11 from Livonia and 12 from Lauban (Wiesenhütter) are also the same species. Of these, the British and the Lauban specimens are marked var. *b*. Therefore, *allionella*, *a*, *b*, Zeller, agree with our British species which we call *aureatella*. The vars. *c*, *d*, *e*, of *allionella*, Zeller, are unquestionably the same species that you met with at Cannes, and that I have determined as *ammanella*, Hb. (= *anderschella*, H.-S.). Zeller's *allionella*, var. *f*, was founded on Thunberg's description of *paykellella*, which we refer to *M. thunbergella* : var. *f*. must consequently follow its type " [*in litt.*, May 24th, 1898].

Frey gives four forms of the species. They are as follows :

1.—Capillis ferrugineis ; alis anter. nitidis, violaceo-purpureis, fascia fere recta prope basim, fascia vix curvata in medio maculaque costæ magna post medium aureis, ciliis marginis postici volaceo-purpureis, 5½—5‴ = *allionella*, Fab.

2.—Fascia media apicem versus incurvata = var. *a*.

3.—Macula costam non attingente = var. *b*.

4.—Puncto aureo costali inter fasciam mediam maculamque costalem.

In order to keep as clear as possible the fact that there appear to be two fairly distinct forms included under this name, we would use two names for these. There can be no doubt, from Scopoli's description, that his name is applicable to our (more or less moorland or heath) British form. This appears to be the form generally found in northern Europe. The second is, as a rule, larger than the first form. It has sometimes, in addition to the outer costal spot, another smaller spot just within it, often in contact with it. It is the form generally obtained in South France, Italy, Switzerland, and parts of Germany. This latter form, we suspect, from the Fabrician statement, "maculisque ejusdem coloris versum apicem," to be *allionella*, Fab. The Fabrician type, too, came from Italy. We thus have two chief forms :—

1. Anterior wings purple, with two golden fasciæ, one towards the base, the other towards the centre, and a costal spot of the same colour towards the apex = *aureatella*, Scop.

2. As 1. but sometimes with an extra costal spot or point just within the first costal spot = *allionella*, Fab. The diagnosis of the latter reads: "Alæ anticæ cupro-auratæ, nitidæ fasciis duabus, altera baseos, altera in medio flavissimis maculisque ejusdem coloris versum apicem. Habitat in Italia, Dr. Allioni" [Fabricius, *Ent. Syst.*, iii. (2), 321, no. 148 (1794)].

EGG-LAYING.—At the end of March, 1897, Chapman met with this species near Cannes, and imprisoned several of the females with damp moss, and succeeded in obtaining eggs in the same way as had been done in the case of *M. calthella*.

OVUM[*].—The eggs are a little larger than those of *M. calthella*, they are similarly clothed, with the snowy exudation forming white filaments.

LARVA.—The young larva does not differ to any appreciable extent from that of *M. calthella*. It is somewhat larger, and less delicate in consequence, and is also, perhaps, whiter in colour. The larvæ appeared to eat a little moss, as evidenced by the coloration of their intestinal contents, but owing to Dr. Chapman travelling at the time, they all died off. The following is a description of the newly-hatched larva : It is about ·95 mm. in length, and of the same truncate angular outline as that of *M. calthella*. The antennæ are similarly very long, and the true legs, and 8 pairs of false legs, have the same structure and relative size as in *M. calthella*. On the first seven abdominal segments there are 10 rows of ball appendages. These occur in double rows, a double row on each side of the dorsum, and a double row on each lateral region, and a double row again on each side below this, such that the upper one is a ball like the others, the lower is one of the false feet, *i.e.*, if the false feet are taken to be representative of the balls there would be 12 rows, 10 rows of balls and two rows of feet, only that the two rows of feet do not form a double row of themselves, but appear to be the lower members of the double row of which the lower row of ball appendages is the other. The reason for taking the appendages thus in double rows is that there is a greater distance from one double row to the next than between the two rows of which it consists. The 1st thoracic segment has two rows transversely, 4 in the first and 3 in the second on either side. The second and third thoracic have the two upper pairs of rows on either side as in the following segments, but, on each, the lower row,

---

[*] The notes on the early stages of this species were made by Dr. Chapman from specimens taken at Cannes, April, 1897. These belonged to the form 2, sometimes with an extra spot between the central fascia and the ordinary costal spot towards the apex = *allionella*, Fab.

just above the feet, has two, one in front of the other. The 8th abdominal segment has one appendage in this row, but above this has two transverse rows of two on either side; the 9th segment has three on either side, and the 10th segment carries the two setæ, which appear to be rather homologous with cerci, than with any ordinary tubercles or processes of lepidopterous larvæ. It appears also to have a similar sucker to that of *M. calthella*, but I did not happen to see it obviously used in the living larva (Chapman, *in litt.*, 25/3/98).

Habitat.—This appears to be somewhat of a moorland species, although also recorded from wooded districts, and Barrett notes it as occurring in a swampy copse near Haslemere, on sedge-blossoms. Edleston reports (*Ent. Ann.*, 1855, 1st Ed., p. 52) having seen many hundreds of specimens, invariably among *Vaccinium myrtillus*, flying over and settling on the plants. Madam Lienig records it as occurring in small woods in Livonia, flying in sunny places over *V. myrtillus* gregariously at the end of May. Meyrick says that it is abundant on the hills at Philippeville and Bougie, resting on flowers in the sun. (Probably this record refers to *M. algeriella*, Rag.) Wilkinson says that at Scarborough it loves to fly about the flowering spikes of wood-sedge (*Carex sylvatica*) in the sun. Frey gives the species as being found on the highest Alps, and Zeller says that it occurs in the Silesian mountains, near their summits, in wooded thickets, but is rare. Among grasses and sedges at Wilsden (Butterfield); abounds in woods near Huddersfield among bilberry (Porritt); in moist woods and meadows at Carlisle (Wilkinson); among bilberry, but settling on leaves of nut in the early morning sunshine, in North Devon (South); flying among the heather at Witherslack (Shuttleworth); flies over the moors at Witherslack, but occurs also in damp woods at Windermere (Threlfall); beaten out of small birch trees in damp spots in Tilgate Forest (Vine); on flowers on mountain-ash at Airthrey (Stainton).

Time of appearance.—Stainton gives May and June for Britain; Zeller, at the end of May and beginning of June in the Silesian Mountains; Zetterstedt says that the species is not rare from July 3rd-22nd in Bjoerkvik in Lapland; Tengström gives June and commencement of July for Finland; whilst Madam Lienig gives the end of May for its appearance in Livonia. In Algeria at Philippeville, etc., it occurs in April (Meyrick). Other recorded dates are:—

June 3rd, 1849, at Airthrey (Stainton); June 9th, 1886, at Chislehurst (Bower); June 26th, 1853, June 17th, 1860, June 15th, 1872, June 13th, 1873, May 26th, 1874, June 2nd, 1875, at Richmond, Yorks, June 21st, 1877, June 7th, 1878, at Wolsingham (Sang, *teste* Gardner); May 30th, 1895, at West Wemyss, June 7th, 1895, at New Park, May 26th, 1895, at Aberfoyle (Evans); May 18th-31st, 1866, near Haslemere (Barrett); May 20th, 1866, at Witherslack (Hodgkinson); May 13th, 1882, at the same locality (Shuttleworth); May 25th, 1874, May 14th, 1875, at Witherslack, June 16th, 1877, May 29th, 1878, at Windermere (Threlfall); May 10th, 1895, in Tilgate Forest (Vine).

Localities.—Aberdeen: Aberdeen (Horne). Berks: Burghfield (Holland). Cheshire: Knutsford (Chappell). Cumberland: Lake District (Stainton), Carlisle (Wilkinson), Hayton Moss (Routledge). Derby: Burton (Brown), Seal Wood (Harris). Devon: North Devon (South). Dublin: Lough Bray (Birchall). Durham: Darlington (Stainton), Wolsingham (Sang). Edinburgh: New Park (Evans). Fermanagh: Enniskillen (Partridge). Fife: West Wemyss (Evans). Gloucester: Bristol (Stainton), Stapleton, near Bristol (Mason). Herts: (Stephens). Hants: Pamber Forest (Holland). Hereford: Tarrington (Wood). Kent: Chislehurst (Bower), Pembury (Stainton). Kerry: Blackstones (Birchall), Killarney (Barrett). Lancashire: Manchester (Stainton), Chat Moss (Chappell), Grange (Threlfall). Northumberland: Newcastle (Stainton). Perth: Abertoyle (Evans), Pitlochry (Beaumont). Somerset: Clevedon (Mason). Staffordshire: Cannock Chase (Barrett). Stirlingshire: Torwood, Airthrey (Stainton). Surrey: Haslemere (Barrett), West Wickham Wood (Douglas), Seale, nr. Farnham (Digby). Sussex: Tilgate Forest (Vine), Ore (Bloomfield). Warwick: Near Birmingham (Stainton). Westmorland: Windermere and Witherslack (Threlfall). Wicklow: In the Wicklow Mts. (Barrett). Yorkshire: York (Stainton), Scarborough (Wilkinson), Huddersfield (Porritt), Richmond (Sang), Wilsden (Butterfield).

Distribution.—Widely distributed throughout the whole of the British Islands—England, Scotland and Ireland. It is also recorded from many countries on the Continent—from Finmark to the Mediterranean, and from Ireland to Russia. It is recorded from: Denmark (B.-Haas). France: Chateaudun (H.-Schäffer), Saone-et-Loire (Constant), Cher (Sand), Savoy (Ghiliani), Cannes (Walsingham). Germany and Austria: Carniola (Scopoli), Vienna, Croatia and Fiume (Mann), Dalmatia (Stainton), Pomerania (Hering), Kiel (H.-Schäffer), Brandenburg and Hamburg (Sorhagen), Thuringia (Knapp), Oberharz (Hoffmann), Riesengebirge (Zeller), Frankfort (Koch), Krain, near Laibach (Schmid), Bohemia (Fischer von Röslerstamm), Harz (Heinemann), Bergün, Beneschau, and the Silesian Mountains (Zeller), Saxony, near Schandau (Tischer), Alsace (Peyerimhoff). Lapland: Stensele, Lycksele, Wilhelmina, Lapponia Umensis, Bjoerkvik Nordlandiae, Dalecarlia (Zetterstedt). Norway: Ostrolandia, Finmarken (Wallengren). Sweden: Smolandia, Ostrogothia, Vermlandia, etc. (Wallengren). Finland (Tengström). Switzerland: Schüpfen, Swiss Alps, Brüschalp in Wäggithal (Frey). Between Frütigen and Kandersteg (Jordan). Russia: Livonia (Lienig), Helsingfors, Sodra Karelen, Abo, Uleäborg (Tengström), Riga, Tursa Moor (Nolcken), Bundelwald, Kokenhausen (Lienig), St. Petersburg (Erschoff). Italy: Piedmont (Fabricius), Tuscany (Mann), Liguria (Ghiliani). Naxos (Mann). Meyrick also records the species as occurring at Phillipeville and Bougie, in Algeria, but one suspects the species was really *M. algeriella*, Rag. Specimens in Constant's collection came from the Pyrenees and Burgundy.

Notes on genera of exotic Micropterygides.

In order to complete the descriptive portion of this superfamily, it may be well to quote Meyrick's descriptions of the Australian genera, *Palaeomicra* and *Mnesarchea*, and to give Walsingham's diagnosis of the American genus *Epimartyria*. These are as follows:—

Palaeomicra.—Imago: Head with long rough hairs; ocelli present; tongue obsolete. Antennæ $\frac{1}{2}$—$\frac{2}{3}$, in male filiform, pubescent, basal joint small, concealed. Labial palpi extremely short, rudimentary. Maxillary palpi long, folded, loosely scaled. Abdomen in male with rounded terminal plate above, valves large. Middle tibiæ without spurs; posterior tibiæ somewhat rough beneath. Fore-wings with vein 1 *a* with long basal furcation, lower fork sometimes (*chalcophanes*) again basally furcate, 1 *b* well-defined, connected with lower margin of cell by a bar near base, 2 and 3 from point of angle, transverse vein sometimes (*chalcophanes*) obsolete between 3 and 4, forked parting-vein well-defined, rising out of lower margin of cell near base, sometimes (*chalcophanes*) connected with upper margin of a bar near base, terminating in 4 and 5, between which the tranverse vein is absent, 7 and 8 stalked. 7 to hind margin, secondary cell well-defined, 9 and 10 out of its upper margin, 11 from $\frac{1}{3}$ of cell, giving rise to an additional vein and connected with 12 by a bar above (*chrysargyra*) or below (*chalcophanes*) connected with upper margin of cell at base, giving rise to an additional vein above in middle, and sometimes (*chalcophanes*) a second near base. Hind-wings rather narrower than fore-wings; ovate-lanceolate, cilia $\frac{3}{4}$, neuration identical with that of fore-wings, except as follows: 1 *b* rising out of upper fork of 1 *a*, not connected with cell, 2 and 3 remote, transverse vein between 3 and 4 well-defined, the four main veins not connected at base of wing, 11 from middle of cell, 11 and 12 without additional branches" [*Trans. New Zealand Inst.*, xviii., pp. 180-181 (1886)].

Comparing this genus with the typical genus *Micropteryx*, Meyrick says it "differs by the stalking of veins 7 and 8 in both wings, and the additional branch of 11 in fore-wings." He further adds [*Tr. New Zeal. Inst.*, xx. (1888), p. 91] that "in *P. doroxena* veins 7 and 8 of both wings are separate . . . . . and the generic definition should be widened to include this case. The genus remains distinct from *Micropteryx* by the presence of the additional branch of vein 11 of the fore-wings."

MNESARCHAEA.—Imago : Head loosely haired, somewhat rough ; tongue obsolete, ocelli present. Antennæ $\frac{3}{4}$, stout, filiform, in male simple, basal joint moderate, without pecten. Labial palpi moderately long, straight, porrected, clothed with long loose scales, forming a dilated terminal brush. Abdomen, in male, with uncus and valves well developed, and two long linear internal processes. Posterior tibiæ thinly clothed with long bristles, middle and posterior tarsi with whorls of projecting bristles at apex of four basal joints. Fore-wings with vein 1 simple, 2 almost from angle of cell, 6 out of stalk of 7 and 8 near base, 7 and 8 stalked, 7 to hind margin, 11 absent. Hind-wings $\frac{4}{5}$ of fore-wings, lanceolate, cilia rather over 1 ; neuration exactly as in fore-wings, except that vein 6 is separate from 7 [*Trans. New. Zeal. Inst.*, xviii., p. 180 (1886)].

To this diagnosis Meyrick adds (*Ibid.*, xx. (1888), p. 90) : "In *M. loxoscia* and *M. hemadelpha*, the tongue is well-developed, and vein 6 of the fore-wings is separate ; in all other respects the structure is identical with that of *M. paracosma*. The antennæ in all the species are clothed with loose hair-scales, arranged in whorls at the joints ; the spurs of the middle tibiæ are well developed."

The comparison of the neuration of *Palaeomicra* with that of certain Trichopterygids led to a most interesting statement by Meyrick, who writes : "The nearest of these (Trichopterygids) to *Palaeomicra* is *Rhyacophila* (*Rhyacophilidae*) ; *Cyrnus* and *Holocentropus* (*Hydropsychidae*) also approximate closely, and *Diplectrona* and *Hydropsyche* in the same family, less nearly ; *Calamoceras* (*Leptoceridae*) is rather more remote. In the fore-wings of *Rhyacophila* the only important difference is the existence of an additional vein rising out of 4 ; but in the hind-wings one observes, with interest, that this very difference has disappeared, this additional vein being absent ; throughout these genera it seems that, in the tendency to a progressive simplification of structure, the hind-wings took the lead, with the result that in the finally established lepidopterous type the hind-wings have permanently four veins less than the fore-wings. *Rhyacophila* shows no other essential difference from *Palaeomicra* ; the other points of difference consist in the position (whether above or below the furcations) of the transverse bars, or their partial obsolescence. *Palaeomicra chalcophanes* is especially interesting, as being at present the only Lepidopteron known which shows the basal trifurcation of vein 1 *a* of the fore-wings, common to all the above-mentioned genera of Trichoptera ; and the same species possesses the second (basal) branch of vein 12 of the fore-wings, which is shown in *Rhyacophila*, but not in any of the others mentioned, except *Hydropsyche*, which does not, however, show the other or median branch. I may add that this basal branch is, perhaps, rather to be regarded as a transverse bar connecting vein 12 with the costa, than as a true branch. It appears to me that the type of neuration of the Trichoptera consists of five simple veins, variously fused towards the inner margin; and seven apically furcate veins, variously fused towards the base, and connected by a series of transverse bars."

The genus *Epimartyria* is intermediate between *Palaeomicra*, Meyr. and *Micropteryx*, Hb. It appears to be more archaic, in some respects, than *Micropteryx*, and more closely allied to *Palaeomicra*. It is diagnosed by Walsingham as follows:—

EPIMARTYRIA.—Imago: Antennæ ($\frac{3}{5}$) moniliform, each bead with a fringe of long hairs from the circle of its widest diameter, projecting forward as far as the middle of the bead above it. Mandibles developed. Haustellum absent. Labial palpi (? absent). Maxillary palpi strongly developed, 5-jointed, scaled, hairy on the basal joints, curved inward. Maxillæ distinct. Ocelli present. Head and face very rough. Fore-wings with the costa somewhat excavate at the base, thence slightly arched, apex rounded; somewhat widened across the middle. Neuration: 1*b* furcate at base, connected by a bar with 1*c*, which has a small fork at the extreme base; vein 2 out of 3 immediately beyond angle of lower cell, 2 + 3 (cubital) continued to near the base, but becoming furcate before the bar from 1*b* to 1*c*; the lower limb of the fork is almost obsolete, and goes to 1*c*; the upper is distinct and goes to the median (4 + 5 + 6); 4 furcate, one limb going to cubital before origin of 2, the other limb to median at about $\frac{3}{5}$, at which point 5 is bent down to unite with it; 5 and 6 separate and almost parallel; 6 furcate at base connecting median with radial; 7 and 8 stalked (7 to slightly above apex) and continued through cell to about midway between 11 and 10; the transverse veins joining 10 to 9, 9 to 7 + 8, and 7 + 8 to 6 are weak, and that between 9 and 10 is furcate, enclosing a small cell between its limbs on vein 10; 11 and 12 connected by a transverse bar, before which vein 12 throws out a branch to the costa; costa chitinised at base, outwardly sharply defined by a short humeral vein; jugum developed; anal margin of the wing chitinised. Hind-wings as broad as the fore-wings, apex rounded; with flat scales. Neuration as in the fore-wings, but 1*b* not furcate at base, 1*c* not connected with cubital, and cubital not connected with median towards base; transverse vein between 9 and 10 not furcate, 11 absent. Abdomen: genital armature, consisting of four lateral plates and strong bifid uncus, the lower plates with a tooth at their apex. Legs with hind tibiæ not hairy above, median spurs moderate, apical very small; middle legs without spurs (*Entom. Record*, etc., pp. 161-162, July, 1898).

The beads of the antennæ have longer stalks, and thus are more distinctly separated than those of *Micropteryx* (*calthella*); moreover, in *M. calthella* they are shaped like a small conical bullet with the base outwards, whereas, in *E. pardella*, they are more spherical, and are vase-shaped, with the mouth straight, and wider than the stem, the middle portion bulged, and almost flanged. No such structure is observable in the normally cylindrical and closely compressed joints of *Eriocrania*, *Z.*

ERRATUM.—p. 160, line 5 from bottom, read "or below (*chalcophanes*) the additional vein, 12 sometimes (*chalcophanes*) connected with upper margin," etc.

Superfamily II: NEPTICULIDES.

This superfamily includes the smallest known of all Lepidoptera, the imagines averaging from 3-8 mm. only in wing expanse. The rough head and face, and folded palpi are very characteristic of the Nepticulid species, whilst the antennæ are short, and not unlike those of the Micropterygids. The anterior wings are short and broad, and the scales comparatively large for the size of the moths. The eggs are laid on a leaf or leafstalk, the young larvæ, on hatching, immediately boring into the leaf-substance directly beneath the egg. The larva lives in the parenchyma, between the upper cuticle and the median vascular structure of the leaf, and makes a mine, the character of which is generally very marked for each individual species. Whether the egg be laid on the upper or underside of the leaf, the larva makes its way (with a very few exceptions) to the upperside, and confines its operations almost entirely to that portion. The larva is without any true chitinous legs, certain of the thoracic and abdominal segments bearing membranous prolongations, analogous in structure with the prolegs of other lepidopterous larvæ, but having no terminal crochets or hooks. De Geer says that there are 9 pairs (Wood allows but 8) of these modified legs of which the third pair is very ill-developed. The larva usually quits its mine in order to spin its cocoon, but those of some species, such as *N. weaveri*, *N. septembrella*, *N. agrimoniae*, etc., make their cocoons in the mine itself. The cocoons vary much in size, shape and colour, and the pupa, in common with those of most INCOMPLETÆ, usually protrudes its head and anterior segments before the emergence of the imago. The pupa itself is a "Pupa libera," with the segments unfixed, and the appendages unsoldered to the rest of the pupal structure. The minute imagines fly freely in the sun, each species having its own particular time of activity, after which they rest in the crannies of the tree-trunks or branches, or sun themselves upon the leaves. In windy weather, they seek the shelter of fences, etc., near their haunts, and we have seen the crannies on the trunks of the oak trees in Chattenden woods, swarming with incredible numbers of *N. subbimaculella* (and smaller numbers of other species) on such days. It is a remarkable fact that, when the leaves containing the mines of these insects fall to the ground in autumn, the part of the leaf containing the mine resists decay long after the rest of the leaf has become withered, the part containing a larva remaining green after the other parts have changed colour.

In 1771, De Geer wrote an excellent detailed description of the life history of *N. anomalella*. In 1793, Fabricius described and named a species of the genus, *N. aurella*. Hübner figured and named two species, but at present they have not been recognised. Haworth, in 1828, gave good descriptions of 10 species, one of which is the Fabrician *N. aurella*, and diagnosed many others, which he treated, however, as aberrations of the species he named. Zeller, in the *Isis* of 1839, diagnosed 8 species, of which 5 were identical with those described by Haworth, whilst in 1848, in the *Linnaea Entomologica*, vol. iii., the same author established 13 species, of which 3 were new. In 1851, Stainton published his *Systematic Catalogue of the Tineidae*, and this contained 18 species of the genus. This was followed (1855) by the *Natural History of the Tineina*, vol. i., in which 33 species were enumerated. In the same year, Herrich-Schäffer in his *Systematische Bearbeitung der Schmett. von Europa* was able to describe 48, whilst Frey, in the *Linnaea Entomologica*, vol. xi. (1857), monographed 58 species. In 1862, Stainton published the *Natural History of the Tineina*, vol. vii., in which the total number of species is placed at 74 certain, 4 others doubtful, and mines of two unknown species from South America. By 1871, Staudinger and Wocke in their *Catalog*, etc., were able to list 111 species then known to inhabit the Palæarctic area. Since then, several other species have been added, of which 6 are British. To Wood's papers on this superfamily (*Ent. Mo. Mag.*, xxix., pp. 197 *et seq.*) we are greatly indebted for much practical information concerning the habits of some of the more obscure species. It is a speaking monument to Stainton and his colleagues, that the life-histories of the species comprised in this large superfamily are, perhaps, better known in England and Germany than those of any other group of equal size, included in the so-called Micro-Lepidoptera.

Besides the large genus *Nepticula*, at least two other genera belong to this superfamily, *viz.*, *Trifurcula* and *Scoliaula* (*Bohemannia*). When more is known of the early stages of other genera, probably also these, too, will have to be admitted.

The impedimenta required for collecting the mines of these species consist only of a small pocket lens, and a few tin boxes in which to carry the leaves containing the mines when found. The specimens in collections are almost all bred from mines thus obtained. The species are mostly double- or continuously-brooded, and the mines may, therefore, be collected in the summer months, although autumn is the time of year usually occupied with this pursuit. The whole existence of one of these mining larvæ is almost always spent within the confines of a single leaf, and hence the area of study is, so to speak, circumscribed within these narrow limits. There are various means of determining, in the larval state, all our British species. The points which aid in this determination are: (1) The food-plant. (2) The position of the egg. (3) The form of the mine. (4) The arrangement of the frass. (5) The structural characters of the larva.

The food-plants of almost all our British species are well-known. The *Rosaceae*, *Salicineae* and the *Cupuliferae* supply, between them, the food-plants of about five-sixths of the British species. The birch supports at least 8 (? 9) species, the oak 5, hawthorn 6, and apple 5, 5 feed on rose, 6 on brambles, at least 3 (? 4) on the willows, and 4 on pear. The *Vacciniaceae* support 2 species, the *Urticaceae* (elms) 3, whilst 6 other natural orders (including the *Leguminosae* and *Labiatae*) contain but one species of plant each, which is known to be acceptable to the Nepticulid larvæ, and each of these is tenanted by only a single species; the single *Hypericum* species, however, is not so particular in its choice of a single species for food-plant. The total number of the British species (including doubtful ones) obtained from the *Rosaceae* and *Cupuliferae* amounts to 58, whilst only 20 are obtained from plants of all other natural orders. Many species are confined to a single food-plant, but others are not so limited. Both the nut species, *N. floslactella* and *N. microtheriella*, are also found on *Carpinus betulus*. *N. aeneofasciella* feeds on *Potentilla tormentilla* and *Agrimonia eupatoria*; *N. oxyacanthella* occurs on apple and pear, as well as on mountain-ash, *Cotoneaster affinis* and hawthorn; *N. atricollis* on apple and hawthorn, as well as on pear; *N. angulifasciella* on *Poterium sanguisorba* as well as rose; whilst Wood gives the palm, in this respect, to *N. aurella*, which, he says, feeds on bramble, strawberry, agrimony and *Spiraea*. He also considers that *N. gei*, from *Geum*, is only a form of this species.

Whether the palm should not be given to *N. oxyacanthella* is doubtful. Fletcher says that he has never found *N. aurella* in the leaves of anything but evergreen bramble (*Rubus fruticosus*), and he suspects that the larvæ on strawberry, agrimony, *Spiraea* and *Geum* are *N. gei*, which he has found in leaves of all these plants. As to *N. aurella* and *N. gei* being different species, Fletcher writes: "*N. aurella* and *N. gei* are very much alike, still I can always breed them pure. The mines are somewhat different, and the larvæ occur at different seasons." He also notes: "*N. splendidissimella* is quite distinct; the mine is more distorted, tends to be more in the outer angle of the leaf, and has a less tendency to run along a vein of the leaf than that of *N. gei*. The larva feeds in dewberry and *Rubus corylifolius*, is local, and is fond of leaves in cover of woods, etc., in Sussex and Lincolnshire, also among rough grass on sandhills at Mablethorpe. I have bred it freely from *Rubus chamaemorus*, from Scotland, but from no other plants. The moth is much smaller than either *N. aurella* or *N. gei* (the comparison is made on 60 specimens, picked from a very much larger number of all three species). *N. splendidissimella* has conspicuously black head, contrasting sharply with the colour of the eyecaps, and always suggests strongly to me that it wears 'gig-lamps'" (*in litt.*, May 18th, 1898).

The following list of the British species of the genus *Nepticula*, arranged according to the natural orders on which the larvæ feed, will help to illustrate the large number of species that feed on plants of the natural orders, *Rosaceae*, *Cupuliferae* and *Salicineae*. The species (which are not arranged with any view to relationship, and often have other food-plants besides those mentioned) are as follows :—

1. Feeding on ROSACEÆ :	FOODPLANT.
N. anomalella, Göze	R. canina, etc.
N. fletcheri, n. sp.	Rosa arvensis
N. angulifasciella, Sta.	R. canina
? N. hodgkinsoni, Sta.	Rosa ? sp.
N. centifoliella, Zell.	R. rubiginosa, ? subsp. micrantha
N. pygmæella, Haw.	Cratægus oxyacantha
N. ignobilella, Sta.	C. oxyacantha
N. atricollis, Sta.	C. oxyacantha, Pyrus malus, P. communis
N. gratiosella, Sta.	C. oxyacantha
N. regiella, H.-Sch.	C. oxyacantha
N. oxyacanthella, Sta.	C. oxyacantha, P. malus, P. communis, P. aucuparia and Cotoneaster affinis
N. pomella, Vaugh.	Pyrus malus
N. desperatella, Frey	P. malus
N. malella, Sta.	P. malus
N. pulverosella, Sta.	P. malus
N. pyri, Glitz	P. communis
N. minusculella, H.-Sch.	P. communis
N. aucupariæ, Frey	P. aucuparia
N. nylandriella, Teng.	P. aucuparia
N. sorbi, Sta.	P. aucuparia
N. torminalis, Wood	P. torminalis
N. prunetorum, Sta.	Prunus spinosa
N. plagicolella, Sta.	P. communis, myrobalana, sinensis
N. filipendulæ, Wocke	Spiræa filipendula
N. poterii, Sta.	Poterium sanguisorba
N. rubivora, Wocke	Rubus cæsius
N. aurella, Fab.	R. fruticosus
N. auromarginella, Rich.	R. fruticosus
N. splendidissimella, H.-Sch.	R. cæsius, R. corylifolius, etc.
? N. tengstromi, Nolck.	Rubus chamæmorus
N. arcuatella, H.-Sch.	Fragaria vesca and ? Potentilla fragariastrum
? N. dulcella, Hein.	F. vesca
N. serella, Sta.	Potentilla tormentilla
N. agrimoniæ, Frey	Agrimonia eupatoria
N. æneofasciella, H.-Sch.	A. eupatoria and Potentilla tormentilla
N. fragariella, Heyd.	Fragaria vesca, Agrimonia eupatoria
? N. gei, Wocke	Geum urbanum, Rubus corylifolius
2. Feeding on CUPULIFERÆ :	
N. atricapitella, Haw.	Quercus robur
N. ruficapitella, Haw.	Q. robur
N. basiguttella, Hein.	Q. robur
N. subbimaculella, Haw.	Q. robur
N. quinquella, Beddell	Q. robur
N. castanella, Edles.	Castanea sativa
N. turicella, H.-Sch. (=tityrella, coll. Ang.)	Fagus sylvatica
N. basalella, H.-Sch. (= fulgens, coll. Ang.)	F. sylvatica
N. floslactella, Haw.	Carpinus betulus and Corylus avellana
N. microtheriella, Sta.	C. betulus and C. avellana
N. alnetella, Sta.	Alnus glutinosa
N. glutinosæ, Sta.	A. glutinosa
N. betulicola, Sta.	Betula alba, ? B. nana
N. woolhopiella, Wood	B. alba

	FOODPLANT.
N. argentipedella, Zell.	B. alba
N. confusella, Walsm. and Wood	B. alba
N. continuella, Sta.	B. alba
N. luteella, Sta.	B. alba
N. lapponica, Wocke	B. alba
N. distinguenda, Hein.	B. alba
? N. bistrimaculella, Heyd.	B. alba

3. Feeding on SALICINEÆ :

N. argyropeza, Zell. (apicella, Sta.)	Populus tremula
N. subapicella, Sta. (argyopeza, Sta.)	ignota
N. assimilella, Zell.	P. tremula
N. trimaculella, Haw.	P. nigra
N. intimella, Zell.	Salix russelliana
N. vimineticola, Frey	S. alba
N. salicis, Sta.	S. caprea, S. aurita and S. cinerea
? N. diversa, Glitz	S. caprea

4. Feeding on URTICACEÆ :

N. ulmivora, Fologne	Ulmus campestris
N. viscerella, Sta.	U. campestris
N. marginicolella, Sta.	U. campestris

	FOODPLANT.

5. Feeding on SAPINDACEÆ :

N. sericopeza, Zell.	Acer campestris

6. Feeding on TILIACEÆ :

N. tiliæ, Frey	Tilia parvifolia

7. Feeding on RHAMNEÆ :

N. catharticella, Sta.	Rhamnus catharticus

8. Feeding on VACCINIACEÆ :

N. weaveri, Sta.	Vaccinium vitis-idæa
N. myrtillella, Sta.	V. myrtillus

9. Feeding on HYPERICINEÆ :

N. septembrella, Sta.	Hypericum quadrangulum, H. perforatum

10. Feeding on POLYGONACEÆ :

N. acetosæ, Sta.	Rumex acetosella

11. Feeding on LABIATÆ :

N. headleyella, Sta.	Prunella vulgaris

12. Feeding on LEGUMINOSÆ :

N. cryptella, Sta.	Lotus corniculatus

The Palæarctic species of the genus, not yet discovered in Britain, are as follows :—

N. samiatella, H.-Sch.	Quercus robur
N. uniformis, Hein.	Salix caprea
N. nitidella, Hein.	Cratægus oxyacantha
N. paradoxa, Frey	C. oxyacantha
N. subnitidella, Zell.	ignota
N. rhamnella, H.-Sch.	Rhamnus catharticus
N. lonicerarum, Frey	Lonicera caprifolium
N. tristis, Wocke	Betula nana
N. sanguisorbæ, Wocke	Sanguisorba officinalis
N. stettinensis, Hein.	Pyrus communis
N. pyricola, Wocke	Pyrus communis
N. ilicivora, Peyr.	Quercus ilex
N. aceris, Frey	Acer campestris
N. latifasciella, H.-Sch.	ignota
N. pretiosa, Hein.	Geum urbanum
N. bollii, Frey	Rubus fruticosus
N. tormentillella, H.-Sch.	Tormentilla erecta
N. dryadella, Hoff.	Dryas octopetala
N. nitens, Fologne	Agrimonia eupatoria
N. comari, Wocke	Comarum palustre
N. penicillata, Wocke	ignota
N. speciosa, Frey	Acer pseudoplatanus
N. mespilicola, Frey	Sorbus aria, Amelanchier vulgaris
N. dewitziella, Sorhgn.	Salix caprea
N. strigilella, Thbg.	ignota
N. gilvella, Rössl.	ignota
N. lemniscella, Zell.	Ulmus
N. ilicella, Wlsm.	Quercus ilex
N. trifolii, Sorhgn.	Trifolium
N. nobilella, Wocke	ignota
N. angustella, Hein. and Wocke	? Tormentilla or Fragaria
N. suberoidella, Wlsm.	Quercus ilex
N. rubescens, Hein.	Alnus glutinosa
N. lediella, Schleich	Ledum palustre
N. inæqualis, Hein.	Fragaria vesca
N. occultella, Hein.	Tormentilla erecta, Potentilla anserina
N. potentillæ, Glitz	T. erecta, Potentilla anserina
N. hübnerella, Zell.	ignota
N. dimidiatella, H.-Sch.	ignota
N. geminella, Frey	Poterium sanguisorba
N. diffinis, Wocke	Sanguisorba officinalis
N. ulmariæ, Wocke	Spiræa ulmaria
N. zelleriella, Snellen	? Salix fusca
N. latifoliella, Mill.	Phillyrea latifolia
N. hemargyrella, Zell.	F. sylvatica
N. flexuosella, Fologne	ignota

	FOODPLANT.
N. freyella, Heyd.	Convolvulus sepium, C. arvensis
N. schleichiella, Frey	Sanguisorba officinalis
N. aterrima, Wocke	Cratægus oxyacantha
N. obliquella, Hein.	? Salix
N. suberivora, Sta.	Quercus suber
N. suberis, Sta.	Quercus suber
N. carpinella, Heyd.	Carpinus betulus
N. fagella, H.-Sch.	?Fagus sylvatica
N. helianthemella, H.-Sch.	Helianthemum vulgare
N. decentella, H.-Sch.	Acer pseudoplatanus
N. rubiella, Rag. (m.s.)	Rubus
N. cistivora, Peyr.	Cistus monspeliensis, C. salviæfolius
N. albifasciella, Hein.	Quercus
N. promissa, Stdgr.	Pistacia lentiscus, Rhus cotinus
N. turbidella, H.-Sch.	Populus nigra, P. alba
N. hannoverella, Glitz	Populus pyramidalis
N. simplicella, Hein.	ignota
N. euphorbiella, Sta.	Euphorbia dendroides
N. alpinella, H.-Sch.	ignota
N. aureocaputella, Mill.	ignota
N. argyrostigma, Frey	ignota
N. wockeella, Hein.	Salix alba

The above forms a moderately complete list of the known Nepticulid species inhabiting the Palæarctic area, with the food-plants of the larvæ. The superfamily has, however, been so little worked outside Europe, that a list, sent to me by Mr. Durrant, appears to be worth reproducing, as it will serve to show not only how cosmopolitan is its range, but what a possibility of discovery there is for any one who will work at the group systematically in those countries from which species have been recorded. This list reads as follows :—

From North America :

Nepticula amelanchierella, Clem.
N. anguinella, Clem.
N. apicialbella, Chamb.
N. badiocapitella, Chamb.
N. belfrageella, Chamb.
N. bifasciella, Chamb.
N. bosqueella, Chamb.
N. castaneæfoliella, Chamb.
N. caryæfoliella, Clem.
N. cilliæfuscella, Chamb.
N. clemensella, Chamb.
N. corylifoliella, Clem.
N. cratægifoliella, Clem.
N. dallasiana, F. and B.
N. fuscocapitella, Chamb.
N. fuscotibiæella, Clem.
N. grandisella, Chamb.
N. juglandifoliella, Chamb.
N. latifasciella, Chamb.
N. maculosella, Chamb.
N. maximella, Chamb.
N. minimella, Chamb.
N. nigriverticella, Chamb.
N. ochrefasciella, Chamb.
N. ostryæfoliella, Clem.
N. platanella, Clem.
N. platea, Clem.
Nepticula populetorum, F. and B.
N. prunifoliella, Clem.
N. pteliacella, Chamb.
N. quercicastanella, Chamb.
N. quercipulchella, Chamb.
N. resplendensella, Chamb.
N. rosæfoliella, Clem.
N. rubifoliella, Clem.
N. saginella, Clem.
N. serotinæella, Chamb.
N. thoracealbella, Chamb.
N. unifasciella, Chamb.
N. villosella, Clem.
N. virginiella, Clem.

From South America :

Nepticula molybditis, Zell.
(Colombia).
N. johannis, Zell.
(Bogota)

From China :

Nepticula mandarinella, Wlsm.
(Chang-hai). M.S.

From New Zealand :

Nepticula tricentra, Meyr.
N. ogygia, Meyr.
N. propalæa, Meyr.

Durrant further writes : "I have seen a species of Nepticula from St. Thomas (Danish West Indies), and Lord Walsingham has undescribed species (more than one) from Australia." Hering, quoting a letter from Hedemann, also notes (*Stett. Ent. Zeit.*) the occurrence of two unnamed species of the genus in the West Indies.

The Nepticulid egg is rather large for the size of the moth, of the "flat" type, ovate in character, roundish-oval in outline, somewhat domed above and flattened beneath, and, in spite of its generalised nature, not unlike that characterising certain superfamilies belonging to the Sphingo-Micropterygid stirps. Chapman states that it is not unlike that of *Heterogenea cruciata* (*asellus*). The larva does not, as is usual with lepidopterous larvæ, eat its way out of the micropylar end, or the upper side of the shell, but bores directly through the base into the leaf below on which the egg is laid. As a result of this the empty egg-shell is usually of a black or brown colour, due to the presence of frass which the larva deposits in it as it bores its way into the leaf.

The position in which the egg is laid is usually very constant for each species. Of 41 species, observed by Wood, 37 exhibited habitually some preference as to the position selected. Sometimes this is merely the selection of one side of a leaf in preference to the other, at other times this preference extends to a particular part of the leaf such as the extreme edge, the shelter of a projecting rib, or other position. The egg of *N. intimella* is placed on the petiole of a leaf of *Salix russelliana* or on the upper surface of the midrib of *S. caprea* for the larva burrows at first into the stalk or midrib, and only, in the latter part of its life, mines the lamina of the leaf. The egg of *N. argyropeza* (*apicella*) is placed on the petiole of an aspen leaf, the larva passing its first stages within the stalk. *N. regiella* and *N. ignobilella* blotch hawthorn leaves, the mines of both beginning as galleries, which run along the margin before proceeding towards the centre of the leaf. The eggs of both species are laid on the underside of the lobes, that of *N. regiella* immediately under the edge, whilst that of *N. ignobilella* is placed well away from it, often quite in the middle of the leaf. Wood says that there is good reason for this extra precision on the part of *N. regiella*, for its gallery being short and coarse, if it did not start true from the first, all its gyrations might fail to carry it to its proper situation, whilst the gallery of *N. ignobilella*, being long and slender, is sure, sooner or later, to reach the edge, and give the larva the necessary knowledge of its whereabouts. In some cases there appears to be no very special reason for this fixed habit, yet variation in this respect scarcely ever occurs, and the position of the egg appears to be quite as reliable a character for the recognition of the species as many others on which the naturalist has to depend, *e.g.*, the first part of the mine of *N. aeneofasciella* is a very long and slender gallery, just like the mine of *N. fragariella* (or *N. gei*); the larvæ, too, are very similar. At this early stage, therefore, a mine of the latter species in a leaf of agrimony (and such an occurrence often happens) could not well be distinguished from that of the former, if it were not for the fact that the egg of *N. aeneofasciella* is always laid on the underside, and that of *N. gei* on the upperside, of a leaf. *N. pygmaeella* and *N. gratiosella* both frequently lay on the narrow leafy frill that edges the stalk of a hawthorn leaf; both mines keep along the edge of the leaf, and are so very much alike that nothing but the position of the egg can determine the species forming the mine, the egg of *N. pygmaeella* being laid on the upper, and that of *N. gratiosella* on the lower, surface of the frill.

One of the four exceptions referred to by Wood as varying in the position in which the egg is laid is *N. salicis*, which, he says, lays its egg on the upper surface of the smooth-leaved *S. alba*, and on the under-surface of the rough-leaved *S. cinerea* and *S. caprea*, the reason suggested by Wood being that, on the latter plants, although the leaves are clothed below with a woolly covering, the hairs stand on end, and the moth is able to push her ovipositor between and reach a firm base; whereas, in the former, the covering is not only extremely dense, but is also brushed close down upon the surface, so that the upper side, where the hairs are not so thick, is selected instead. It has been suggested to us by Fletcher, that the species on *Salix alba* is *N. vimineticola*, which not only differs in its mode of egg-laying, but also in its cocoon, etc., from *N. salicis*, which is the species found on *Salix cinerea* and *S. caprea*.

The adult larva is flattened, with a very small pointed head, notched deeply behind. The head is almost buried in the tumid and projecting prothorax, which is wide, but less so than the mesothorax. The width of the latter is maintained somewhat uniformly to the 7th abdominal segment, the hinder ones diminishing rapidly, the 9th and 10th abdominal segments being very small and somewhat telescoped. The legs, as already noticed, are remarkable, having the usual proleg structure, but being without hooklets. They are also much more prominently developed in some species than others. Wood says that there are no legs on the prothorax, large ones on the meso- and metathorax, none on the 1st, but present on the 2nd to the 7th abdominal segments—eight pairs in all. De Geer states that "the larva (of *N. anomalella*) has eighteen legs, all similar in form, all membranous, fleshy and destitute of hooks, without any ordinary true legs. The legs are all similar to those of the larvæ of sawflies, pyramidal or conical in shape. A pair is placed on each of the nine segments which follow the first, the first, eleventh and twelfth body segments being devoid of legs." De Geer further states that the larvæ can walk on all kinds of surfaces, the whole body and legs being covered with a sticky or viscous matter which retains them on the objects upon which they walk. Some larvæ (*e.g.*, that of *N. septembrella*) appear to have no legs. The segments of the larva are distinctly separated by a deep incision, with a round (rather than oval) section, whilst the meso- and metathoracic segments are somewhat square in outline. The transparency of the dermis and the tissues generally, allow some of the internal organs to come into view.

The most important larval characters that have been used for the discrimination of the various species are as follows: (1) The general colour of the body. (2) The colour of the head. (3) The markings on the prothorax. (4) The medio-ventral chain of marks extending down the abdomen. (5) The colour of the intestinal canal. (6) A pair of dark lines on the dorsum of the 7th, 8th and 9th abdominal segments.

The larval ground-colour varies, according to the species, from greenish-white to bluish-green, the intermediate tints of some shade of yellow and green being the most common. There is occasionally some fading of tint as a larva reaches maturity (and this probably explains apparent discrepancies in different descriptions of larvæ of the same species). The head varies from pale grey to black, pale brown or an amber tint, being, perhaps, the most common, but the ground-colour of the larvæ of the same species varies but little, hence it becomes a useful character in their determination. The mouth-parts are almost always reddish.

The markings of the larva are important, because on these the differentiation of allied larvæ often has to be made. Of these the following are the chief: (1) A square-shaped spot usually present on the underside of the prothorax. (2) A pair of superficial skin marks on the dorsum of the prothoracic segment (these appear to be the remnants of a prothoracic plate). (3) A pair of deep-seated, pear-shaped, elongate, dark prothoracic marks in line, or nearly so, with the posterior lobes of the head, lying just beyond the tips of the latter. These are the cephalic ganglia, they are of firm texture, and can readily be dissected out. Their conspicuousness depends, apparently, less on their black or brown colour, than upon the contrast that the latter bears to the colour of the head. When the ganglia and the head are of the same colour, the former appear to be (when the head is retracted) simply elongations of the head lobes. (4) A series of ventral markings consisting of a chain of narrow, spindle-shaped or linear marks, down the middle line of the abdomen. This is the deep-seated ventral nerve cord. (5) A series of large, conspicuous, square-shaped, surface spots, covering a large portion of the ventral area, found, however, in but few species, of which the "*angulifasciella* group" offers the best example. These spots usually disappear (except on the venter of the prothorax) with the last larval moult, and thus allow the nerve-cord to come into view.

The ventral nerve-chain is known by the linear character of the ganglia, the three thoracic ganglia being wider or more oval than the eight abdominal ones. The eleven ganglia can generally be counted (by the aid of a good lens) and the bands connecting them in some species, double in the abdominal, as well as in the thoracic, region; in the green-coloured larvæ, however, the ganglia and bands are practically invisible. Wood has observed that when the cephalic ganglia are noticeable on the dorsum of the prothorax, no trace of the ventral ganglia is to be found, in some larvæ, on the venter. This want of agreement in the colour of the supra- and infra-æsophageal parts of the nervous system was found to be connected with the position of the larva in the mine. Probably one-third of the Nepticulid larvæ mine, venter uppermost, and when this is the case, the ventral cord is coloured and visible, whilst, when the dorsum is uppermost, the cephalic ganglia have the colour intensified. Wood considers that light, being the most general and potent factor in the production of pigmentation, has, by pouring through the transparent tissues upon the nerve ganglia, in the course of generations, exaggerated and intensified their colour, so that when the head is uppermost, the light falls upon the cephalic ganglia and, in the course of ages, has blackened them, whilst the ventral cord, protected by the contents of the intestinal canal, retains its primitive colouring. On the other hand, when the position of the larva is reversed, the cephalic ganglia remain unchanged, and the ventral cord is darkened. The rule, however, is not invariable, many larvæ showing both the cephalic ganglia and ventral cord, but even then the darker is always the one more exposed to the light. The high colouring of the nerve centres in so many of the yellow larvæ, and its remarkable absence in the bright green ones, is explained by Wood as being due to the green larvæ rejecting the actinic or chemical rays, whilst they are the ones retained by the yellow larvæ, so that the light is largely robbed of its power to produce pigmentation in the former class, but remains unaffected, as regards this property, in the latter class.

The intestinal canal is usually of some shade of red, yellow or green. Frequently the front is of a different colour from that of the hinder part. In some of the birch-feeders it is of a vivid green. The colour, of course, does not rest in the intestinal canal itself, but in the contained food altered by the secretions used in digestion. In cases where the larvæ (*e.g.*, *N. pyri* and *N. oxyacanthella*) eat the same food, the difference in the colour of the intestinal contents (red and yellow respectively) must be due to the difference of the secretions.

The pair of brown or black lines found on the dorsum of the hinder segments are supposed to be renal organs. They are situated, one on each side of the intestinal canal, and are best seen from the ventral surface. Each is seen, under a microscope, to be resolved into a long, wavy, or tortuous tube, bent upon itself in such a way that the two ends lie close together at the anal extremity. They are best seen in such larvæ as those of *N. distinguenda*, etc., which show an excess of pigmentation. Many of the Nepticulids are said to be double-brooded, but we have a strong suspicion that some of these species produce a succession of broods under favourable conditions.

Our knowledge of the hybernation of many species is still in a very unsatisfactory state. Some species, certainly, like the Eucleids, pass the winter as larvæ in the cocoon, pupating in the spring. Many other species, *e.g.*, *N. minusculella*, *N. atricollis*, *N. decentella*, *N. sericopeza*, also hybernate in the larval stage, but appear to leave their hybernacula to spin their cocoons in the spring. Many failures to breed species having this habit, may be due to the fact that the vessels in which their mines are kept are not tightly closed in the spring, and that the larvæ wander away to pupate, rather than to the usual explanation that the larvæ or pupæ have dried up. The larvæ of both *N. decentella* and *N. sericopeza* appear to spin temporary autumnal cocoons for hybernation, which they leave in spring in order to find a fresh situation for pupation—the former in the crevices of the bark, the latter on the newly-growing leaves and keys.

Although many species are more or less double-brooded, and others, for a few months, even continuously-brooded, yet others are, in this country, unfailingly single-brooded, *e.g.*, *N. weaveri*, *N. agrimoniae*, *N. rubivora* and *N. angulifasciella*.

Nor is the continuous-brooded habit of some species at all remarkable if the shortness of their larval life be taken into account. Of this Heinemann writes (*Wien. Ent. Monats.*, 1862, p. 237): "The duration of the larval stage of some species is extremely short, especially in the summer brood, yet possibly the different species vary much in this respect. In the summer brood of N. *malella*, Buchheister noticed that on a young apple tree frequented by these larvæ, after he had very carefully removed from individual twigs every mined leaf, in thirty-six hours he already found empty mines, and I have noticed similar occurrences with N. *plagicolella*. On the other hand, of the autumnal brood of *N. plagicolella*, I have had larvæ still in the mine for five or six days after the last moult, and the same has happened with larvæ of *N. splendidissimella*, *N. rubivora*, *N. anguli-*

fasciella, *N. ruficapitella*, and others. The larvæ of *N. aceris* must have a very short duration of life, even in autumn, for, although the mines are not scarce on some maple trees and maple bushes on our promenades here, neither in summer nor autumn have I yet succeeded in finding a mine still tenanted, although I have searched the said trees and bushes almost daily."

Warren mentions a disease to which Nepticulid larvæ are sometimes subject. He writes: "This disease would seem to commence with a discoloration of the dorsal vessel alone, the larva ceases to feed, and dies *in situ*, after which the whole body becomes dark. This mortality is not attributable to the attacks of ichneumons, but is possibly owing to premature wet and cold weather in the autumn; the larvæ try to feed up too fast, and pay the penalty." Durrant, on the other hand, associates this, or a similar disease, with exposure to excessive heat, which also appears to be disastrous.

The nature of the mine offers excellent characters for the differentiation of many species, and Wood has made himself so distinctly the authority on this part of the subject in Britain, that we have drawn largely on his papers,* not only for the detailed descriptions that follow, but for much of the information that may be found scattered throughout the preceding and succeeding paragraphs.

The mines of some species are not difficult of detection, but a certain amount of training is necessary to find those of others, *e.g.*, Stainton writes (*Zoologist*, 1853, p. 3955) as follows: "About the middle of October last (1852), I paid a visit one morning to a bush of *Rhamnus catharticus*, on which I expected to find the autumnal brood of the larvæ of *N. catharticella*. To my surprise, on carefully examining the bush, I could not find a single larva; however, I was so satisfied that they must be there, that I continued to look, and as my eyes gradually became more accustomed to the indications of those objects for which I was searching, I found that, so far from there being no larvæ before me, they were really there in hundreds."

The position of the mine is of comparatively little importance, although even this is diagnostic of certain species. Thus, a mine at the foot of an aspen leaf is that of *N. argyropeza* (*apicella*); the small blotch projecting from the side of the midrib into the lamina of a willow-leaf betokens *N. intimella*, whilst *N. subbimaculella* is almost invariably found in one of the angles of the midrib of an oak-leaf. The mines of *N. regiella* and *N. ignobilella* are found on the margins of a hawthorn leaf, and a mine towards the centre is always suspicious. *N. turicella* (*tityrella*, coll.) usually keeps to the narrow space marked off by two adjacent veins of a leaf, and so, can generally be distinguished at once from *N. basalella* (*fulgens*, coll.), which occupies more than one interspace. Mines are always placed on the upper side of a leaf, even when the eggs are laid below, the newly-hatched larva boring at once towards the upper surface, as if to get to the brighter and sunnier side.

The characters of the mine are of much more importance than its position in the determination of species. The mine may be a gallery (*N. alnetella*), a blotch (*N. argentipedella*), or a compound of the two (*N. angulifasciella*). But the blotches are really of a composite nature starting first as a gallery of varying size, sometimes long and hair-like, at others short and twisting, and hidden away in a corner of the blotch, as happens in *N. woolhopiella*. Wood writes (*Ent. Mo. Mag.*, xxix., p. 269): "It would appear that the gallery was the primitive form, and that the blotch came as an after-development, a view that is strengthened by other considerations as well. The so-called vermiform mines, which form blotch-like patches on the leaves, are galleries, folded back upon themselves over and over again in a series of coils. They owe their form to the circumstance that the larva confines its operations to the narrow space bounded by two parallel ribs, for as soon as it is brought up by the rib on one side, it turns sharply round until brought up again by the rib on the other side, and so on, backwards and forwards in this zigzag fashion. Usually strips of tissue are left between the coils, but occasionally the latter inter-communicate freely, and the mine might very well pass for a blotch, were it not that the broad and winding frass-track still remained to indicate its true nature. That some blotches may have originated from these vermiform mines seems likely enough, though probably most of them are merely the natural development of that tendency which some galleries have to widen rapidly and out of all proportion to the growth of the larva, so that it is sometimes hard to decide whether they shall be called galleries or blotches." The mine of *N. argentipedella* is in the form of a more or less circular blotch in which no sign of a gallery can be detected.

---

* *Entom. Mo. Mag.*, vol. xxix., pp. 197 *et seq.*

The galleries are sub-divided by Wood into (1) wide and (2) narrow, the latter being by far the more numerous. The course of the gallery is of importance, whether straight (usually running by the side of a leaf vein) or curved and twisting, and the same may be said of the commencement of the gallery, for, in this, useful distinctions are also to be found. In some mines, this is straight and fine, in others short and coarse; some pass directly from the site of the egg, others form little bunches of convolutions, but Wood considers that the arrangement of the frass* in the mine is, if anything, more valuable than any of the other characters for the ready determination of the species.

In a wide gallery, in which the parenchyma has been well removed, the larva packs its frass behind it in a narrow continuous track down the middle of the mine, whilst in a narrow mine, the larva is obliged to turn its body first in one direction and then in another, in order to find a vacant space in which to deposit the frass, and so the latter is scattered irregularly through the mine. In a very narrow or very shallow mine the frass pellets are packed with the greatest precision in slightly curved rows across the mine. From the resemblance of the superimposed rows of pellets when thus arranged, to the coils of a spring, Wood terms this the "coil arrangement." Classifying these then, we get three forms of arrangement: (1) Collected into a central thread, with a free margin on either side (*N. ruficapitella*, *N. minusculella*). (2) Scatttered irregularly over the mine (*N. argentipedella*). (3) Arranged in "coils" (*N. basiguttella*, *N. pyri*). Some larvæ, however, use more than one method of disposing of their frass, depositing it in one part of the mine in one way, in another part in a different manner, the change in method usually indicating a larval moult. The larva of *N. anomalella* does so.

---

* With regard to this Wood says: "The various forms of frass arrangement are of especial interest as illustrating the effect of physical conditions on the habits of an insect, for there can scarcely be a doubt that the various forms that the arrangement of the frass takes, are governed in the main by the transverse capacity of the mine, as this is determined partly by the breadth of the mine, and partly by the extent to which the parenchyma is removed (*Ent. Mo. Mag.*, xxix., p. 270).

It has been stated that the division of the various forms of mine into gallery and blotch, is more or less artificial, and that there are no sharp boundaries between the various forms which frequently pass by easy gradations into each other; yet they are sufficiently constant for the species to be assumed with almost absolute certainty, if sufficient allowance be made for the nature of the leaf, in those species which have more than one food-plant, or the manner in which the leaves differ as to the quality, texture or thickness of the parenchyma. When this is so, there is almost always some variation in the normal position, shape, or other character, of the mine. Some species have dimorphic mines, the difference between the two forms of mine being dependent upon the difference existing between the leaves of the respective food-plants on which the larvæ may happen to find themselves feeding, and Wood says that one species, *N. salicis*, makes mines of three different forms, its mine being condensed into a vermiform gallery in *Salix aurita*, fairly straight in *S. caprea*, whilst in *S. alba* and *S. russelliana* the mine becomes a blotch, the difference depending entirely on the character of the leaf in which the mine is made. There is some probability, as before suggested, that the mine in leaves of *S. alba* is that of *N. vimineticola*.

It would appear that in many species when the egg is laid on the margin of a leaf (instead of more towards the centre) the normal shape and character of the mine are altered, the mine in such cases being spread out along the margin, and hence, it often happens that two species, evidently closely allied in the larval and imaginal states, will make very different-looking mines. It is clear that this is due to the position in which the egg is laid, and hence a difference in the shape of the mine need not betoken a want of affinity.

Although Herrich-Schäffer (*Correspondenzblatt*, ii., p. 174) was the first to notice the moulting of the Nepticulid larva, Heinemann first described the abnormal method in which the moulting was carried out. He states that the larva is inactive for a time just before a moult is to take place. The skin then cracks at the head, and the larva proceeds to eat its way forward, because it can only, by eating a path before it, obtain space to draw itself from its old skin. This, in the confined space of the mine, gets drawn forward for a slight distance, and is eventually lost to sight in the excremental track. He observed the moulting in several species, and had remarked that it generally took place at some part of the mine where the latter changed its character, either from a slender gallery to a blotch, or from a spiral mine to an irregular one, or from a very narrow gallery to a broader one. Healy observed a larva of *N. aurella* resting in the centre of its mine on January 18th, 1863, "apparently in a sickly state. On the following morning the skin split at the first segment, and the darkest blotch at the back of the head had receded to the second segment. On the 20th the old skin had shrunk to the fifth segment, and at this date the whole of the first four segments had quite a transparent appearance, being devoid of all markings whatever, and contrasting strangely with the remainder of the body of the larva; the larva lay quite motionless in the mine. On the 21st the mouth had regained its former brownish colour, and the larva now moved its head about in a languid manner in search of food, of which it partook sparingly. On the 22nd the darkish blotch had reappeared on the back of the head of the larva, the old skin in the meanwhile having shrunk still lower down ; the anterior portion of the body had now become much stouter, and had a more healthy and fresher appearance ; the larva now commenced feeding with great eagerness ; at this period the dorsal vessel, which had lately become more distinct at the fore and after part of the larva's body, was quite hidden in the centre. On the 23rd the whole of the dorsal vessel was distinctly visible, the anterior portion being of a much brighter green than the posterior."

Heinemann states that whilst observing the larvæ of *N. splendidissimella*, *N. angulifasciella*, *N. rubivora* and *N. ? trimaculella*, in the act of moulting, he was much astonished at the appearance of an extraordinary series of regular oblique, quadrangular, dark, dorsal spots, which gave the larva an appearance as if it were decayed and spotted. These spots appeared at the moult and disappeared at its completion. He says: "As the larva gradually crept out of its old skin these spots remained in their place, and the pale green or pale yellow larva, which had assumed a fresh colour, no longer showed any trace of them. More frequently the spots moved, as well as the old head, a short distance forward with the larva, but the row did not always remain complete, and no longer so decidedly along the back of the larva ; but as the latter, in eating, turned to the side, and so took up a curved position, the green dorsal line in *N. angulifasciella* and *N. rubivora* was perceptibly on the side of the row of spots. Later these spots became lost in the excrement track. Hence it appears that the larva assumes these spots during the moulting, that these are on the old skin, which it is on the point of casting off, and that in the narrow mine of the larva the old skin is drawn forward for a short distance." It is very doubtful whether Heinemann's statement that the spots of these larvæ appeared at this moult is correct. It is well known that the larvæ of the members of the *angulifasciella* group have these dark ventral markings previous to the last moult, and that they are then lost. Wood says:—"The large square-shaped spots are surface markings, though, to be strictly accurate, they are rather transversely oblong, with the corners rounded, than square-shaped. Their size and deep black colour make them extremely conspicuous, but, curious to say, they disappear with the last moult from all the segments save the prothorax. . . . . Both in their general appearance and in the circumstance of being limited to the middle life of the larva (I should add that they are not present from the first), they remind one of the ventral spots in some of the Micropterygids. Comparatively few species, however, seem to possess them. The only ones I know of are the members of the *angulifasciella* group, *subbimaculella*, *argentipedella*, and, I think, *quinquella*" (*Ent. Mo. Mag.*, xxx., p. 44). This would suggest that Heinemann, though correctly observing the disappearance of the marks, was in error in supposing them to have become visible only at the commencement of moulting.

The moulting of the Nepticulid larva was worked out at length by Wood, chiefly by observation of the caterpillar of *N. angulifasciella*. By a combination of different expedients narrated (*Ent. Mo. Mag.*, xxix., p. 271) at length, it was found that the larvæ of many species moulted three times, and Wood concludes that three is the usual if not the invariable number of moults in Nepticulid larvæ.

With regard to the segmentation of the mine corresponding roughly with the moults of the larva, as pointed out by Heinemann, Wood tells us decidedly that the relative width of the different parts helps but little, as the mines widen so gradually that there is no marked increase at the moulting points. The frass, however, in the early part of the mine (corresponding with the first two skins of the larva), looks as if it had been deposited in a soft condition, and had run together into a homogeneous thread. In the second part (corresponding with the third larval skin) the frass is usually more or less grained, whilst in the third (final) part (corresponding with the fourth larval skin), the frass is arranged in one of the three characteristic methods described above. A change in the colour of the frass sometimes marks the occurrence of a larval moult. The evidence seems to point out that those larvæ that make blotches, do so directly after the last larval moult, the gallery portion belonging to the first three skins.

Before leaving the mines of the Nepticulids, there is one character that must not be overlooked. Von Heyden, at Mainz, in 1843, made some observations on the genus *Nepticula* and (as quoted by Zeller, *Linn. Entomologica*, iii., p. 302) stated that "in some species of the genus, *e.g.*, *N. cursoriella* (*subbimaculella*), the larva, when the leaves decay in autumn, is sometimes not fully grown, and requires further food, which it obtains in this singular way, that the cellular substance around the abode of the larva remains green and fresh, long after the other parts of the already fallen leaf have become dead and brown." Stainton, in the *Natural History of the Tineina*, vol. i., p. 268, quotes this, and states that he made the same observation quite independently. Wood was the first observer who attempted to give an explanation of this remarkable and striking prevention of the desiccation of the leaf tissue, in which the mine happens to be situated. He says: "It is a most curious and striking phenomenon. The leaf shall have put on its red or yellow autumnal tint, it shall even have dropped from the tree, have died and turned brown, but the area in which the larva is feeding will remain alive and green, not merely for days but for weeks provided it be not exposed to excessive dryness." He states that the fall of the leaf is associated with an acid condition of the sap, and that the changes in the leaf bring about the acidity of the sap. The phenomenon then is due to a property of the leaf tissue itself. Increased irritation, he argues, stimulates an increased flow of sap to the part, and further that a free supply of sap is conducive to the longevity of leaves; but the length of time that the vitality is retained makes this explanation insufficient, and Wood writes: "Looking at one of these green patches, with its margins fading gradually into the surrounding brown area, it is almost impossible to escape the conviction that it is produced by some substance that we may call a poison, or better still, looking at its effects, a preservative, which, taken up by the sap, is carried to the cells, and being appropriated in its progress gets more diluted and attenuated the further it travels. What this substance may be, whether a secretion specially provided for the purpose, and poured out from the mouth of the larva, or possibly some excretory substance present in the frass, I am quite unable to say. At any rate the whole virtue of the operation seems to be exercised whilst the larva is still young, and, once accomplished, the life or death of the creature is of little or no consequence." He considers that in the very earliest stage the larva "catches and impregnates the sap in its passage out of the vascular bundles." He points out that even if the larvæ of *N. subbimaculella*, *N. apicella*, or *N. intimella* die in their mines in an early stage, the part of the leaf in which they commenced to form their mines is still preserved, and he says: "the only plausible explanation I can see is that some substance is produced which, being absorbed by the vascular bundles among which the larva is burrowing, gets distributed to the parts of the leaf they supply, where it is taken up and appropriated by the cells."

The phenomenon is noticeable also in the mines of the Lithocolletids. In those of the Nepticulids the patch fades insensibly into the surrounding area, in the Lithocolletids it occupies exactly the area of the mine itself. The virtue of the preservation, Wood says, "lies in the first stage of the work, *viz.*, in the separation of the cuticle, for the larva, having effected this, may come to grief, and yet the patch it has so cunningly marked out for its future use will remain green and fresh, as if nothing were amiss, whilst the rest of the leaf may have long since gone through the whole series of autumnal changes." He states that although the Nepticulid larva does not eat down the veinlets to the same level as the parenchyma, it does nibble them, and thus gains access to the vascular bundles, and so to the general current of the circulation. In this way, by the assumption of some product of the larva as the real efficient cause, and mechanical irritation but a subsidiary one, Wood allies the process with that of gall formation, especially as seen in the *Cynipidae*, in which the poison is provided by the larva and not by the parent insect at the time of oviposition.

The Nepticulid pupa has the "eye-collar" exceedingly well-developed. By examination of the pupæ of this superfamily, Chapman was able to prove that this (eye-collar) was the case of the maxillary palpus, and that its appearance of coming not from the mouth, but from under the antennæ, and, passing inwards, is in agreement with the actual fact. The palpus 5 (or 6 ?) jointed, on leaving the maxilla passes backwards in the angle between the head and the prothorax, until it is situated deeply beneath the antenna, then it turns forwards to the antenna, and only reaches the surface by emerging from beneath the antenna, and, turning inwards, forms the "eye-collar," which contains only its terminal joints, the others being concealed deeply. The parts of the Nepticulid pupa separate readily on slight violence, so much so that it is not easy to be sure whether the first free segment is the second abdominal or the third, but Chapman believes it to be the latter.

When the imago is matured, and ready for emergence, the pupa forces its anterior segments out of the cocoon. It is remarkable that the newly-emerged imagines do not, as do most newly-emerged Lepidoptera, stand so that the expanding wings may hang downwards, but remain on a horizontal surface, the wings gradually stretching until the full size is attained, when they are thrown perpendicularly over the back.

As the chief imaginal features, Heinemann discusses (1) the colour of the cilia, (2) the length of the antennæ, (3) the cervical tuft on the middle of the prothorax, (4) the colour of the middle pair of tibiæ, (5) the neuration.

With regard to the colour of the cilia, Heinemann asserts that on this character the imagines may be divided into two great sections: (1) The base of the cilia of the anterior wings clothed with broad scales, which are pale at their bases and dark at their apices, so that the cilia appear to be more or less pale with dark spots. These spots generally arrange themselves so as to form several dark lines intersecting the cilia entirely or partially, especially at the anal angle; the outer line is always the most distinctly and decidedly expressed, and often it is the only one in which the spots unite to form a distinct line. In some few species, *e.g.*, *N. salicis*, *N. floslactella*, *N. viminetícola*, this line is not generally distinct, but the dark ends of the scales project irregularly in the cilia; but in all cases the latter, beyond such a line or beyond the dark scales, decidedly and abruptly defined, are paler, generally whitish. (2) Although scales project from the base of the cilia, they are narrow, very little paler at the base than at the apex, and, therefore, do not form so sharp and conspicuous a line as in most of the species in the preceding section; and, although, in these, the tips of the cilia are paler, sometimes even whitish, the colour only becomes gradually lighter, and certainly more from the pale lustre of the tips of the cilia, whilst the latter in certain directions are always distinctly grey. This divisional line in the cilia is termed by Heinemann "the cilial line." On this character Herrich-Schäffer separated *N. turicella* from *N. basalella* (*tityrella*), *N. salicis* from *N. floslactella*, and *N. arcuatella* from *N. fagi*.

As to the characters furnished by the length of the antennæ, it is necessary to premise that usually the antennæ are longer in the male than in the female, and therefore it is necessary to compare males with males and females with females. Heinemann says that "in a great number of species the antennæ of the males reach above two-thirds or even three-fourths of the length of the anterior wings, in which case the antennæ of the females have rather more than half the length of the wings; in other species the antennæ of the males hardly reach beyond the middle of the costa, and the antennæ of the females are considerably less than half as long as the wings. Some few species stand midway between these sections."

Of the cervical tuft, Heinemann writes: "Sometimes this is white, and then forms, with the eye-caps, when the insect is sitting with its antennæ set back, a distinct white collar; in the red and yellow-headed species the cervical tuft is often of the same colour as the frontal tuft, but paler, and frequently it is quite concolorous with the thorax."

According to the same observer the middle tibiæ are generally markedly paler than the posterior tibiæ. Often they are quite white, whereas in other species they are nearly as dark as the posterior tibiæ, *e.g.*, *N. plagicolella* is readily separated from its nearest allies by its dark middle tibiæ. But since the colouring of the tibiæ varies considerably with the direction of the light falling upon them, they rarely afford, except in a few striking instances, a certain character.

Herrich-Schäffer noticed that there were two forms of neuration in the Nepticulids, one more complicated, the other simpler; whilst

Heinemann showed that there was a third or intermediate form, and that one of the forms noticed by Herrich-Schäffer could easily be derived from the other. He says: "In the more complicated form, the sub-costal and sub-dorsal nervures are present; both are forked between one-third and one-fourth of the length of the wing and the anterior branch of the sub-dorsal nervure, and the posterior branch of the sub-costal nervure, as it turns first towards the inner margin and then towards the costa, runs into the last-named after first emitting a branch to the inner margin, and then parallel to this a branch to the apex, or to the costa just before the apex. By the intersection of the branches of the two main nervures, a short middle cell is formed, included by the two main nervures, and their converging branches to the spot where the latter meet. The anterior branch of the sub-costal nervure runs in a straight direction to about the middle of the costa; the posterior branch of the sub-dorsal nervure first runs obliquely towards the inner margin, curves beyond the middle of the wing towards the apex, and terminates quite close to the branch of the sub-costal nervure, which runs to the inner margin, or even unites with it. The dorsal nervure runs obliquely towards the inner margin, is then curved forwards, and beyond is parallel to the inner margin; beyond the middle of the wing it approaches the posterior branch of the sub-dorsal nervure, and often runs into it quite in the same way as the latter runs into the posterior branch of the sub-dorsal nervure. This form of neuration has been observed in *N. angulifasciella*, *N. agrimoniae*, *N. argentipedella*, *N. argyropeza*, *N. turbidella*, *N. subbimaculella* and *N. simplicella*.

"In *N. tityrella* (*basalella*) and *N. weaveri*, the neuration differs, in that the posterior branch of the sub-dorsal nervure is wanting, and this, therefore, runs quite simple from the base to the costa, intersecting the posterior branch of the sub-costal nervure soon after the forking of the latter, and hence the dorsal nervure remains separate and further removed from the branches of the two main nervures, and terminates in or near the inner margin at about three-fourths of the length of the wing. In *N. tiliae*, *N. anomalella*, *N. regiella*, *N. gratiosella*, *N. splendidissimella*, *N. plagicolella*, *N. betulicola*, *N. malella* and *N. septembrella*, the sub-dorsal nervure is entirely wanting. The latter is very fine and short in *N. ruficapitella*, *N. salicis* and *N. myrtillella*, and terminates before it reaches the posterior branch of the sub-costal nervure, so that in these species the cell is wanting.

"Sometimes the sub-costal nervure forks again soon after the first furcation, emitting a second branch to the costa, which corresponds with the anterior branch of the sub-dorsal nervure in the more complicated form, from the place where it intersects the posterior branch of the sub-costal nervure and then proceeds to the costa. In other words, in the more simple form the sub-dorsal nervure and its posterior branch is entirely wanting, and the anterior branch is wanting from the point of intersection of the two intersecting branches of the two nervures. Lastly, in the more simple form there is also wanting one of the last three branches of the sub-costal nervure which terminate near the apex of the wing; the latter is consequently represented as a nervure, which runs first parallel to the costa, then turns sharply towards the inner margin, and at the same time sends two parallel branches to the costa, and lastly is again forked before the apex of the wing, emitting two branches towards it. In all the three forms the costal nervure is very short and fine, and terminates on the costa near the base, often hardly distinct; the dorsal nervure is not furcate towards the base, and is not double. What Herrich-Schäffer calls "Rippe 1b," and Zeller and Frey call the fine upper nervure of the fork, is the delicate fold of the wing, which approaches the dorsal nervure in the middle and usually unites with it, although sometimes it remains perceptibly distinct.

"The posterior wings have only one median nervure, which forks, sooner or later, and runs with the two forks to the margins or towards the apex of the wing, besides this there are one costal and two dorsal nervures" (Heinemann, *Ent. Annual*, 1863, pp. 47-49).

With regard to the affinities of the Nepticulids, little is known, Chapman considers them to have originated from the more primitive Lepidoptera, but with none of the landmarks now left to show the line of their evolution. He has pointed out, however, several remarkable parallels between them and the Eucleids (Limacodids), which are here quoted. Chapman writes: "In many respects *Limacodes* and *Nepticula* seem extremely different, and apart from the matter of size, the larva of the former is an external feeder. The neuration of the imagines of the latter is crippled by the minute size of the moths, so as to render them very different, though probably not essentially so in this respect. It is, therefore, somewhat surprising to find a resemblance that is almost identity in the pupa. In both, the pupal skin is very delicate; the free abdominal segments begin at the first; the appendages are easily separated, as they might be in a bee or beetle pupa; the dorsal spines are arranged in several rows of small equal points towards the dorsal margin of the segment. The maxillary palpus is strongly developed, and, on dehiscence, remains attached to the head coverings. It is, indeed, larger proportionally in these genera (*Apoda* and *Heterogenea*), where it is obsolete in the imago, than in *Nepticula*, or others where it persists in the imago. The pupa emerges from the cocoon in much the same manner, and leaves a very delicate pupa-case, in which, after the manner of the *Incompletae*, the covered parts are nearly as strong as the exposed. The Eucleid larva passes the winter in a passive state in the cocoon, changing in spring; whilst its apod character might be explained by its very recent descent from a footless mining larva. The urticating properties of sundry exotic species of the group, may, perhaps, be allied in nature to the excretion discharged by some of these miners (especially *Nepticula*), of some poison that retards the autumnal decay of the leaf they inhabit. *Nepticula* and *Limacodes* present us, indeed, with the Incomplete pupa in an extreme form; the empty pupa-skin has every segment and each appendage quite free from the others. The dorsal armature consists, in Cochliopods, of a number of rows of very fine spines, all belonging to one series. In the species of *Nepticula* examined there are no spines to the hind margin, but the anterior set forms, in some species, a single row of largish spines, in others two and three rows; in the latter instances the spines are much smaller. There is, therefore, a variability in the armature that might easily extend to include the Cochliopod form. *Nepticula*, however, has one character, that I have not met with elsewhere, *viz.*, the antenna-cases on dehiscence divide into the cover of the first joint and that of the remainder, each separate from the head, yet still held together sufficiently to keep their places fairly. The egg of *Heterogenea asella* is a flat, colourless, transparent speck, much like that of *Nepticula*, but not resembling that of any true Bombycid species" (Chapman, *Trans. Ent. Soc. London*, 1893, pp. 115 *et seq.*).

Meyrick writes: "*Nepticula* is a very large genus, quite cosmopolitan, but probably attaining its greatest development in Europe. Owing to their small size, and the similarity of appearance, the species present considerable difficulty, and have been so much neglected that their distribution is hardly known except in England and Germany, and even there very imperfectly. Most of the species can seldom be obtained except by rearing the larvæ, but some fly freely in the sunshine. Imago with fore-wings lanceolate. Larva without developed legs or prolegs, but with pairs of rudimentary ventral processes on 3, 4, and 6—11, or rarely wholly apodal. Pupa in a firm cocoon usually outside the mine" (*Handbook*, etc., p. 711).

As a matter of fact, with the exception of Fernald, there is scarcely a really good micro-lepidopterist in North America at the present time, yet, there is a by no means small list of American Nepticulids, and one would suspect that if properly worked, the Nearctic would be fully as productive in species belonging to this superfamily as the Palæarctic region.

There is no doubt that the NEPTICULIDES are a very ancient superfamily. The larval habit of mining in leaves has resulted in the traces of the work of a larva being discovered in a leaf found in brown coal of Lower Miocene age. This mine was described under the name of *Nepticula fossilis*, in Meyer and Dunker's *Palaeontographica*, x. (1861-3), and mentioned by Goss, *Proc. Geol. Association*, v., No. 6, p. 57 (1877). That the group is much older than this there cannot be the least doubt. One would suppose that it existed throughout the Mesozoic period, and probably far back into Palæozoic times.

As to the ease with which these charming atoms can be collected, Wood tells us that he has captured, near Tarrington, on a bit of rough, hilly country, on the limestone, barely three miles across in any direction more than fifty species. It is of very little use attempting to collect many of these species in the imaginal state, in fact, some species, common enough as larvæ, are never seen in the perfect condition at all. When the leaves containing the mines are picked, they must be put at once into tins, and not allowed to become too dry. On arrival home the mines should be sorted carefully, each kind of mine being separated from those of a different species; the leaves of each separate batch should then be loosely but carefully rolled up in some soft paper, and placed into a tin or glass jar. The larvæ feed up so rapidly that at the end of a week, at most, they will have left the leaves and spun their cocoons, generally in little clusters on the paper. They can then be removed to little glass tubes, or to flower-pots with a glass cover, and labelled with the name of the plant, and a note as to the manner of mining. Many larvæ of those species that feed up in the autumn do not pupate until the spring, and since some leave their cocoons at this time, and seek a fresh place in which to pupate, care must be taken that they do not then escape. Like almost all species of Lepidoptera that hybernate as larvæ in their cocoons, Eucleids, etc., the Nepticulids can be bred throughout the winter by bringing the cocoons into a warm room. Owing to the fact that their larvæ may be collected in late autumn, when other entomological field-work is almost over, and that they can be then forced to emerge in the winter at will, many entomologists have occupied themselves with these charming little atoms, for they can set them uninterruptedly throughout the winter, when there are practically no other insects to set. Some few species, however, are often abundant enough in the imago state, *e.g.*, *N. subbimaculella*, *N. quinquella*, etc., resting in the crannies of oak trunks. *N. intimella* is to be obtained by sweeping the ends of the sallow branches; *N. pygmaeella* flies freely from 5-6 a.m., and *N. gratiosella* on a sunny afternoon. The species, however, are, as a rule, much better bred.

Frey says that although 46 species of the genus *Nepticula*, and 2 of *Trifurcula* occurred in Switzerland in 1858, only 2 species of the former genus, and 1 of the latter, occur in the Alps from 5,000-7,000 ft. altitude. The two *Nepticulae* were *N. septembrella*, found on one of the Glarus Alps, in 1857, at an elevation of 5,400 ft., and the blotch mine of a species on mountain-ash (*Pyrus aucuparia*), which also occurs at Zürich. Bremi-Wolff found, years before, a species of *Trifurcula* abundantly on the Righi (*Ent. Ann.*, 1858, p. 146). Of the distribution of the Nepticulid species at considerable altitudes, Heinemann observes that on the Upper Harz, at 2,800 feet above the sea, he found, in June, mines of *N. weaveri* on *Vaccinium vitis-idaea*, and in July he found mines of an unknown species on *Pyrus aucuparia* (the imagines, which had red heads, and a silvery fascia across the fore-wings, died in the pupa-case, and so failed to emerge). In the same place he met with some specimens of a third species amongst *Vaccinium myrtillus* and *V. uliginosum*, but only caught one specimen, in bad condition. This proved not to be *N. myrtillella*, but bore considerable resemblance to *N. lapponica*.

Family: NEPTICULIDÆ.

In spite of the great amount of information that has accumulated relating to the life-histories of these moths, and the number of students who have from time to time been engaged in unravelling their habits, little enough is known of many essential points in their structure. Even the variation of the neuration indicated by Heinemann has never yet been worked out by those versed in this particular branch of study, and no grouping on the lines indicated has yet, we believe, been attempted. The result is, that the superfamily at present contains only one recognised family, and the latter three genera, all so nearly allied as to be united into a single tribe. True, Staudinger and Wocke include [*Catalog*, etc. (1871), p. 335] the genus *Opostega* in this family, but of this remarkable genus that exhibits the extreme of neurational specialisation, inasmuch as there are only three unbranched nervures to the fore-wings, so little is known that it is difficult to say with any precision to what superfamily it does belong. The only three genera represented certainly in the Palæarctic area are *Nepticula*, *Trifurcula* and *Scoliaula* (*Bohemannia*).

The number of Palæarctic species enumerated in Staudinger and Wocke's *Catalog*, etc. (1871), pp. 335-340, is as follows:—*Nepticula*, 111 species; *Trifurcula*, 5 species; *Scoliaula*, 1 species. This list was almost entirely confined to species found in Britain, Germany and

Switzerland, and as the number of workers in other countries has not increased to any great extent, a list compiled at the present time consists of but little more than the additions made since 1871 by the British and German lepidopterists, united to Wocke's list of that date—an approximate list of this kind has been compiled, *ante*, pp. 166-167. At the present time the number of British species may be put down at—*Nepticula* 78 (including five or six species doubtful), *Trifurcula* 3 (one of the species, *squamatella*, included in Wocke's *Catalog*, etc., having since been united with *immundella*) *Scoliaula* (*Bohemannia*) 1 species.

We have, in the genus *Nepticula*, a certain number of British species whose right to specific claim is doubtful. Of these the best known are *Nepticula atricapitella* and *N. ruficapitella*, which are sometimes considered but one species. Stainton says (*Nat. Hist. Tin.*, i., p. 276) that they pair true, and should be considered as really distinct, also that the larva of *N. atricapitella*, like the moth, has a black head, and can by this be distinguished from that of *N. ruficapitella*. On the other hand, in the MS. *Catalogue* of Stainton's British collection (by Hampson), we observe that specimens of *N. atricapitella* are recorded as being bred from "pale-headed" larvæ, and many specimens of both *N. atricapitella* and *N. ruficapitella* are recorded as bred from "dark" larvæ and "pale" larvæ, apparently indiscriminately. Sorhagen writes ["*Die Kleinschmett. der Mark Bradenburg*" (1886), p. 302] that "Dr. Hinneberg, on April 28th, 1885, observed, at Potsdam, *N. ruficapitella*, *in copulâ* with *N. atricapitella*, whereby, probably, all doubt as to their identity is removed." The second pair of doubtful species comprises *N. argyropeza*, Sta. and *N. apicella*, Sta., which are said to = respectively the *N. subapicella*, Sta. and *N. argyropeza*, Zell. The *N. argyropeza* of Zeller (= *N. apicella*, Sta.), is the *P. tremula* species, which is certainly British, but is *N. subapicella* (=*N. argyropeza*, Sta.) a distinct species from it? Other doubtful species include *N. obliquella* (*diversa*), so called British specimens of which may be *N. salicis* or *N. vimineticola*, making elongate mines in large leaves of *S. caprea*; also *N. dulcella*, British specimens of which may constitute a small form of *N. fragariella*. *N. filipendulae*, Fletcher says, "may be *N. poterii* feeding in *Spiraea filipendulae*. *N. poterii* is very local, its food-plant very abundant. *N. filipendulae* is widely distributed on the Sussex downs, though its food-plant is less abundant, and I have never yet found the two Nepticulids on the same ground, though the food-plants are fairly mixed." On the other hand, Fletcher writes: "I am not at all sure that we may not have two species included in *N. anomalella*, alluded to by Stainton (*Nat. Hist. Tin.*, i., p. 58), *viz.*, a larger one—the imago, with *bright yellow face and head*, the larva feeding in hedgerows on *Rosa canina* and *R. rubiginosa*, and in gardens on several species of rose. I have bred it pure in large numbers from rose "Rampant," which is I think a var. of *Rosa sempervirens*. The larva of the other, smaller form, the *imago with black hairs on head*, feeds in *Rosa arvensis*, in woods, chiefly under shade of trees. I have met this form in Sussex and Lincolnshire." Again, *N. hodgkinsoni* has not yet been very definitely distinguished from *N. centifoliella*, and one would like more light on the former species. *N. tengstormi* claims its place as British on a single specimen bred from Scotch larvæ. *N. castanella* is only known as British from specimens captured by Edleston, in the "fifties," at Bowdon, and although Wocke records the species from South France, Italy and the Tyrol, we cannot trace the records on which the statement is based. *N. gei*, Wocke, was sunk by Wocke himself as being identical with *N. fragariella*, but the mine in *Geum* is broader than that in *Fragaria*, and although this does not count for much, in such a difficult group, the point is worth more definite attention than has as yet been given to it, and one would like to see the life-histories of the insects from the two food-plants, set out in two parallel columns. We have two beech-feeding Nepticulids in Britain, but the species we call *tityrella* is most probably the *turicella* of the Continental entomologists, whilst our *fulgens* (=*basalella*) appears to be not only their *tityrella*, but actually the *tityrella* of Stainton, so that *fulgens*, Sta. = *tityrella*, Sta., and the *tityrella* of British cabinets = *turicella*, H.-Sch. *N. bistrimaculella* is probably British, specimens referable to this species having been bred, we believe, by Vine, from larvæ taken in birch in the Brighton district. *N. tormentillella* has been introduced and re-introduced as British, but the species has probably not yet been taken in Britain. There are other insects whose right to a position on the British list is as yet more or less doubtful, but each will be dealt with separately and the arguments for or against the claims of each will be given when each of these species is considered. A few alterations in the list already compiled (*antè*, pp. 165-167) may be necessary as the details relating to each species are further elucidated.

Subfam.: NEPTICULINÆ.

Tribe: NEPTICULIDI.

Genus: NEPTICULA, Heyd.

SYNONYMY.—Genus: *Nepticula*, Heyden, "Bericht der Versammlung der Naturforscher zu Mainz (1843), p. 208; Zell., "Linn. Ent.," iii., p. 301 (1848); Sta., "Cat. Brit. Tin.," p. 28 (1849); "Ins. Brit. Tin.," p. 295 (1854); "Nat. Hist. Tin.," i., p. 34 (1855); Frey, "Die Tineen und Pterophoren der Schweiz," p. 368 (1856); Heinemann, "Wiener Ent. Monatschrift," 1862, p. 237; Staudinger and Wocke, "Catalog," etc., p. 335 (1871); Nolcken, "Lep. Fn. Estland," etc., p. 752; Heinemann and Wocke, "Schmett. Deutsch.," ii., p. 727 (1877); Snellen, "De Vlinders van Nederland," ii., p. 978 (1882); Sorhagen, "Die Kleinschmett. Brandenburg," p. 301 (1886); Meyrick, "Handbook," etc., 710 (1895). *Microsetia* (in part) Stephens, "Illustrations," etc., iv. (1835), p. 268 [Westwood cited *T. stipella*, Hb., 138, as type of *Microsetia*, in the *Syn. Gen. Br. Ins.*, p. 112 (1840)]; Kirby, "Handbook Order Lepidop.," v., p. 313. *Lyonetia* (in part), Zeller, "Isis," 1839, p. 215.

Heyden cites the following species under *Nepticula*: *aurella*, Fab., *argentipedella*, Zell., *centifoliella*, Hgn., *sericopeza*, Zell., *cursoriella*, H. [*N. aurella* may be cited as the type].

Zeller's diagnosis of the genus (*Linn. Ent.*, iii., p. 302) is as follows:—

"Caput lanatum, etiam in epistomio. Antennæ breves crassæ, conchula modica instructæ. Palpi breves, penduli. Alæ anteriores grosse squamatæ; vena subcostali furcata, ramo inferiore cum mediana per venulam cohærente; vena mediana postice in tres ramos divisa, subdorsali in basi furcata: posteriores ovato-lanceolatæ, vena media longissime furcata. Larva pedibus veris 4, spuriis 12, prædita (Heyden)."

The main characters of the genus would appear to be as follows:

IMAGO.—Head hairy; tongue rudimentary; antennæ with basal joint enlarged to form an eye-cap; maxillary palpi rather long, folded; labial palpi short, slightly porrected; fore-wings rather broad, short and coarse scales; hind-wings lanceolate; (neuration variable, *vide*, *ante*, pp. 178-180).

PUPA.—Libera, with segments and appendages free, *i.e.*, not soldered; maxillary palpus exceedingly well developed; pupa in cocoon; partly protrudes from cocoon before emergence of imago.

Larva.—Head small; pro-thorax tumid; no true legs, but 9 (8?) pairs of membranous prolegs without hooklets (some species without prolegs); dermis transparent; segmental incisions well defined; mines in leaves, and lives on the parenchyma.

Ovum.—Large for size of moth; flat and scale-like; roundish-oval in outline; micropyle at one end.

Group I.—Cilia of the anterior wings with no dark divisional line, but cilia becoming gradually paler towards their tips. Anterior wings with no distinct fascia.

NEPTICULA ATRICAPITELLA, Haworth.

Synonymy.—Species: *Atricapitella*, Haw., "Lep. Brit.," pp. 585-586 (1828); Stphs., "Illus.," iv., p. 269 (1835); Sta., "Sys. Cat.," p. 28 (1849); "Ins. Brit.," p. 297 (1854); "Nat. Hist. Tin.," i., p. 8 (1855); "Manual," ii., p. 431 (1859); H.-Schäffer, "Sys. Bear.," v., p. 347, fig. 1086 (1855); Frey, "Die Tineen," etc., p. 370 (1856); "Linn. Ent.," xi., p. 368 (1857); Heinemann, "Wein. Ent. Monats.," pp. 241, 246, 256 (1862); Hnm. and Sta., "Zool.," xxi., pp. 8356-8357 (1863); Staud. and Wocke, "Cat.," p. 335 (1871); Nolcken, "Lep. Fauna Estland," p. 754 (1871); Millière, "Cat. Lep. Alp.-Mar.," p. 372 (1875); Hein. and Wocke, "Schmett. Deutsch.," p. 731 (1877); Sand, "Cat. Lep. Auv.," p. 200 (1879); Snellen, "Vlinders," etc., ii, p. 981 (1882); Peyer., "Cat. Lep. Als.," 2nd Ed., p. 163 (1882); Curò, "Atti della Soc. Nat. Modena," xvi. (1883); Sorhagen, "Die Kleinschmett. Mark Brandenburg," p. 302 (1886); Meyrick, "Handbook," etc., p. 714 (1895). ? *Samiatella*, Zell., "Isis," 1839, p. 215; "Linn. Ent.," iii., p 303 (*teste* Snellen).

Original description.—"*Tinea* (The black-headed Pygmy) alis auratis costa limboque postico purpurascentibus, capite atro. Expansio alarum 2¾ lin. Præcedenti (*violacella*) simillima, sed dignoscitur primo intuitu capite aterrimo nec ferrugineo, lamellâ albâ ad antennas instructo. Alæ anticæ auratæ margine postico late purpurascente. Costa etiam certo situ late purpurascit. Habitat prope Londinum infrequens" (Haworth, *Lepidoptera Britannica*, pt. iv., pp. 585-586).

Imago.—Head black. Anterior wings 5-6 mm. in expanse; shining dark greenish-bronze in colour, the tip of the scales tinged with violet. especially at apex, and along the costa; cilia blue-black, apical half from apex to anal angle pale greyish, at inner margin blackish-grey. Posterior wings blackish-violet, slightly bronzy, cilia similarly coloured, but with grey tips.

Sexual dimorphism.—The blue-black cilia extend in the female almost to the base of the wing without perceptibly decreasing in length, and in set specimens they distinctly lie over the posterior wings. The anal tuft is greyish in the male, and rusty-yellowish in the female (Heinemann).

Ovum.—The egg (or rather the empty shell is what one finds and sees) is laid on the underside of an oak-leaf, just within the margin; in a bright light it looks like a globule of quicksilver. It is bright and polished, and no marking or sculpturing can be detected and distinguished from the network afforded by the frass with which the shell is packed. It is margined by a border of the gum with which it is attached to the leaf. It is dome-shaped, but apparently rather longer in one diameter than the other, *viz.*, length ·26mm., width ·23mm.; the height appears to be ·1mm., but this is, of course, rather guesswork, as the lower surface is absent, and one assumes it is level with the free border, but very probably it bulges in some irregularity of the leaf (Chapman, *in litt.*).

Mine.—The larva makes very slender galleries in oak-leaves, as yet not separated from those of *N. ruficapitella*. Heinemann says that he has "bred large numbers of *N. atricapitella* and *N. samiatella*, H.-Sch., from the larva, but without being able to find any difference between the mines or larvæ, or between those of these species and *N. ruficapitella*. The excremental track is very variable—sometimes like a thin line, sometimes it almost fills the entire mine, but generally it is midway between the two extremes." He further adds that he "attempted to separate the mines by the form of the excremental track: this was, however, not entirely practicable, owing to the very imperceptible gradations, and eventually all three species came from the same mines." Snellen says: "The mine is long, begins as a fine gallery, which widens slowly and regularly until its termination. The excrement lies as an almost uninterrupted, black central thread." Sorhagen writes: "The mine is placed sometimes at the margin, sometimes in the middle of the leaf. It is very long and tortuous, commences very finely and widens gradually, until at its termination the width is considerable. The frass-line is blackish, and varies much, sometimes occupying only the central line of the mine, at other times entirely filling it."

Larva.—The larva is yellowish in colour, and so similar to that of *N. ruficapitella*, that there is great difficulty in determining them. Stainton remarks that "the larva of *N. atricapitella*, though resembling in habit that of *N. ruficapitella*, has, like the imago, a black head" (*Nat. Hist. Tin.*, i., p. 24). Yet, from the catalogue of his collection at the British Museum (South Kensington), one finds that he bred the species, some from larvæ with dark brown, others with pale, heads.

Cocoon.—The cocoon is said to be like that of *N. ruficapitella*, and Hind states that it is "reddish" in colour. Snellen says that it is of a clear, light red-brown when first made, becoming darker later. Its form is almost regularly oval.

Food-plants.—*Quercus pedunculata* (Frey); *Q. robur* and *Q. sessiliflora* (Stainton); *Q. pubescens* (Millière).

Time of appearance.—The species is double-, or partially double-brooded, appearing in May, and again in August, from larvæ found in September-October, and July respectively. Stainton captured imagines on May 16th, 1852, May 30th, 1876, June 5th, 1877, at Lewisham, on May 20th-21st, 1851, June 2nd, 1852, and May 12th, 1852, at Beckenham, and on July 29th, 1851, on *Artemisia vulgaris*, on Dartford Heath. He bred the species on April 5th, 1853; April 20th, 1855 (from pale-headed larva), on April 26th, 1853 (from dark-? headed larva), on March 11th, 1854 (from brown-headed larva), on April 8th, 1854, and May 5th, 1855.

Localities.—Cambridge: Cambridge (Warren). Dorset: Weymouth (Richardson), I. of Purbeck, (Bankes), Bloxworth (Cambridge), Glanvilles Wootton (Dale). Durham: Darlington (Stainton). Gloucestershire: Bristol (Stainton). Hereford: Tarrington (Wood). Kent: Lewisham and Beckenham (Stainton), Eltham (Bower), West Wickham (Bankes), Chattenden (Tutt). Lancashire: Manchester (Stainton). Lincoln: nr. Alford (Fletcher). Norfolk: Norwich (Barrett), King's Lynn (Atmore). Suffolk: Tuddenham (Warren). Surrey: Haslemere (Barrett). Sussex: Lewes (Stainton), Goring Woods, generally abundant in oak woods in the county (Fletcher). Yorkshire: Doncaster district, generally distributed and common (Corbett), Scarborough (Stainton), York (Hind), Huddersfield (Inchbald), Richmond (Sang). Scotland: To the Clyde (Meyrick).

Distribution.—Austria: Reichstadt and Vienna (Mann). France: Nohaut, Indre (Sand), Cannes (Millière). Germany: widely distributed and common (Heinemann and Wocke); Frankfort-on-Main (Heyden), nr. Glogau (Zeller), Potsdam, Berlin, Friedland, Hamburg, Stettin, etc. (Sorhagen), Brunswick (Heinemann), Pomerania (Hering), Alsace (Peyerimhoff). Italy: Tuscany (Mann), Trieste, ? Nizzardo (Curò). Netherlands: widely distributed and not rare (Snellen). Russia: Pichtendahl (Nolcken). Switzerland: nr. Bremgarten (Boll), nr. Zürich (Frey).

NEPTICULA RUFICAPITELLA, Haworth (? var. præc. sp.).

SYNONYMY.—Species: *Ruficapitella*, Haw., "Lep. Brit.," pt. iv., p. 586 (1828); Stphs., "Ill.," iv., p. 269 (1835); Wood, "Index," etc., 1363 (1839); Sta., "Sys. Cat.," p. 28 (1849); "Ins. Brit.," p. 297 (1854); "Nat. Hist. Tin.," i., p. 272, pl. vii., fig. 2 (1855); "Man.," ii., p. 431 (1859); H.-Sch., "Sys. Bear.," v., p. 348 (1855); Frey, "Die Tineen," etc., p. 371 (1856); "Linn. Ent.," xi., p. 370 (1857); Staud. and Wocke, "Cat." etc., p. 335 (1871); Nolcken, "Lep. Fn. Est.," p. 755 (1871); Wallgrn., "Bihang Vet.-Ak. Handl.," iii., p. 80 (1875); Mill., "Cat. Lep. Alp.-Mar.," p. 372 (1875); Hein. and Wocke, "Schmett. Deutsch.," p. 730 (1877); Sand, "Cat. Lep. Auv.," p. 200 (1879); Wallgrn., "Ent. Tids.," i., p. 125 (1881); Snellen, "Vlinders," etc., ii., p. 981 (1882); Peyer., "Cat. Lep. Als.," 2nd Ed., p. 163 (1882); Curò, "Atti della Soc. Nat. Modena," xvi. (1883). ? *Samiatella* ♀, Zell., "Isis," 1839, p. 215; Linn. Ent., iii., p. 303, in part (*teste* Frey). *Atricapitella*, Sorhagen, "Die Kleinschmett. Brandenburg," etc., p. 302, in part (1886); Meyr., "Handbook," etc., p. 714, in part (1895). *Lamprotornella*, Heyd. (*teste* Frey).

ORIGINAL DESCRIPTION.—*Tinea* (The red-headed Pygmy) alis anticis auratis, limbo postico purpurascente; capite rufescente. Expansio alarum 2¾.‴ Præcedenti (*atricapitella*) vix differt nisi in capite rufo seu ferrugineo nec aterrimo, et costa absque purpureo. Habitat prope Londinum (Haworth, *Lepidoptera Britannica*, pt. iv., p. 586).

IMAGO.—Head ferruginous. Anterior wings 5-6 mm.; rather pale bronzy in colour, with the apex violet, the cilia greyish. Posterior wings pale grey with still paler cilia.

COMPARISON OF N. RUFICAPITELLA WITH N. ATRICAPITELLA, ETC.—The bronzy basal half of the anterior wings does not allow of its being confused with either *N. pygmaeella*, *N. oxyacanthella* or *N. viscerella*. *N. anomalella* has the basal half of the wing of a paler bronze, and the apex of the wing is more abruptly violet, besides being a smaller insect. *N. ruficapitella* comes nearest to *N. atricapitella*, from which, however, it can be at once distinguished by the colour of the head, which, in *N. ruficapitella*, is reddish-yellow, whereas in *N. atricapitella* it is black. In the latter species, the ground colour of the anterior wings is a little darker than in the former, and the wings being rather broader and shorter, give *N. atricapitella* a more thick-set appearance (Stainton). Sorhagen states that *N. atricapitella* is the ♂ and *N. ruficapitella* is the ♀ of the same species, and mentions that Hinneberg found the two forms *in cop.* at Potsdam, on April 28th, 1885. Stainton states that "the capture of several pairs of *N. atricapitella*, *in copulâ*, shows that the species are really distinct." Bankes thinks that *N. ruficapitella* and *N. atricapitella* are probably one and the same species. He adds: "In some species of *Nepticula* the colour of the head is very inconstant, but the difference is not sexual; whilst in others the difference in the colour of the head is sexual" (*in litt.*).

EGG-LAYING.—The egg is laid on the underside of an oak-leaf, close to a rib.

MINE.—The mine is at first exceedingly slender, but gradually becomes broader, until at its termination it has reached a considerable width. It is irregular, long, wavy, and of a pale greenish-white colour. In the first part of the mine, the excrement runs through as a very fine continuous line, hardly pale margined at the sides. In the next portion, the excremental line is broader, and often interrupted, but still always forms a dense mass, and on each side a faint narrow light space is perceptible; in the last portion, the mine expands, and the excrement is thinner, more scattered, but still only occupies the centre of the mine, leaving a considerable space on each side. Frey describes the mine as "Mässig geschlängelt, ziemlich unregelmässig gestaltet, liegt bald am Rande, bald in der Mitte des Blattes. Sie beginnt sehr fein mit einigen starken Windungen und wird dann nach unten bis 1½‴ breit. Der Koth liegt in zusammenhängender Reihe als braunschwarzer Streifen. Unterwärts bleiben die Seitentheile des Ganges leer, welche an der frischen Mine weissgrün, später gelblich braun erscheinen" (*Die Tineen*, etc., p. 371).

Larva.—Length 2 lines; rich yellow in colour, shining, dorsal vessel reddish; the head and the two posterior lobes, which show through the upper surface of the second segment, pale reddish-brown (Stainton). It is this larva that is referred to by Stainton (*Zool.*, 1853, p. 3959) as the "dark-coloured larva of the oak."

Cocoon.—The cocoon is rather flattened, oblong-oval, and dull reddish-orange in colour. One end is rather broader than the other, and from this the pupa protrudes its anterior segments before the emergence of the imago (Stainton). Frey writes: "Der Cocon ist ein unregelmässiges Oval von einer ziemlichen Abflachung und hoch rothbraun, vielleicht etwas weniger dunkel als derjenige der vorhergehenden Art (*atricapitella*)."

Food-plants.—*Quercus robur* and *Q. pedunculata*. *Q. suber* (Millière).

Time of appearance.—The species is double- (or partially double-) brooded, the imagines appearing in May, and again in August, the former brood being by far the more abundant. The larvæ of these broods may be found in October-November, and July respectively. Frey gives it as distinctly double-brooded in Switzerland. Reuter captured it on May 13th, 1886, on the I. of Aland. Stainton's specimens were bred as follows: February 27th, 1852; April 1st, 18th, 27th (from dark larva), May 1st (from pale larva), July 28th (from large larva), August 11th, 16th, 1853; March 29th, April 21st, 1854; May 2nd, 8th, 1855; April 4th, 1859, all from Beckenham and Lewisham; imagines captured May 16th, 1852, at Lewisham, and May 17th-20th, 1851, and June 2nd, 1852, at Beckenham. Atmore notes the species, May 15th, 1898, at King's Lynn.

Localities.—Berks: Reading (Hamm). Cambridge: Cambridge (Warren). Cheshire: Bowdon (Edleston), Bromborough to Eastham (Gregson). Derby: Burton (Sang). Dorset: Weymouth (Richardson), Bloxworth (Cambridge), Glanvilles Wootton (Dale). Durham: Darlington (Stainton). Gloucester: Bristol (Stainton). Hereford: Tarrington (Wood). Kent: Lewisham and Beckenham (Stainton), Eltham (Bower), West Wickham (Bankes), Chattenden (Tutt). Lancashire: Manchester (Stainton), Preston (Threlfall). Lincoln: woods nr. Alford (Fletcher). Norfolk: Norwich (Barrett), King's Lynn,common (Atmore). Northumberland: Newcastle (Stainton). Suffolk: Tuddenham (Warren). Surrey: Haslemere (Barrett). Sussex: Lewes (Stainton), Goring Woods, etc., abundant in oak woods throughout Sussex (Fletcher), Guestling (Bloomfield). Westmorland: Windermere (Hodgkinson). Yorkshire: Scarborough (Stainton), York (Hind), Richmond (Sang); generally distributed and common (Porritt); generally distributed in Doncaster district, and common (Corbett).

DISTRIBUTION. — Austria: (Frey). France: Cannes (Millière), Nohaut, Indre (Sand). Germany: generally distributed and common (Wocke), Alsace (Peyerimhoff), Silesia, Frankfort-on-the-Main (Heyden), Warmbrunn and Glogau (Zeller), Potsdam (Hinneberg), equally distributed with *N. atricapitella*, of which it is the ♀ (Sorhagen). Italy: Tuscany (Frey), ? Livorno and Montenero (Curò, who refers to specimens taken by Mann on "elm"). Netherlands: same distribution as *N. atricapitella* (Snellen). Russia: I. of Aland (Reuter). Pichtendahl (Nolcken). Scandinavia: Scania (Wallengren). Switzerland: Bremgarten (Boll), nr. Zürich, much more common than *N. atricapitella* (Frey).

NEPTICULA POMELLA, Vaughan.

SYNONYMY.—Species: *Pomella*, Vaughan, "Ent. Weekly Intell.," v., pp. 43-44 (1858); Sta., "Man.," ii., p. 431 (1859); "Nat. Hist. Tin.," vii., p. 146 (1862); Hein., "Wien. Monats.," 1862, p. 253; Hnm. and Sta., "Zool.," xxi., pp. 8353-8354 (1863); Nolck., "Lep. Fn. Est.," p. 752 (1871), Staud. and Wocke. "Cat.," p. 335 (1871): Herklots, "Bouwstoffen," etc., iii., p. 400; Hein. and Wocke, "Schmett. Deutsch.," p. 729 (1877); Sand, "Cat. Lep. Auvergne," p. 200 (1879); Peyer., "Cat. Lep. Alsace," 2nd Ed., p. 163 (1882); Snellen, "De Vlinders," etc., p. 978 (1882); Meyr., "Handbook" etc., p. 714 (1895). *Pygmaeella*, Frey, "Die Tineen," etc., pp. 371-372 (1856); Linn. Ent., xi., p. 371, in part (1857).

ORIGINAL DESCRIPTION.—The imago expands about three lines, and is of the unicolorous group; the anterior wings cinereous, glossy, and with a purple hue, brightest towards the apex; the posterior wings of an uniform paler colour; head rufous with whitish eyecaps. In the perfect state it is closely allied to *N. pygmaeella* (Vaughan, *Entomologist's Weekly Intelligencer*, vol. v., pp. 43-44).

IMAGO.—Head ochreous. The anterior wings 6-7 mm. in expanse; glossy, unicolorous grey, tinged with purple, especially towards the apex; the apical cilia dark grey, those at the anal angle rather paler. Posterior wings and the cilia dark grey. [The imago is closely allied to that of *N. pygmaeella*, but the anterior wings are broader and more purple].

SEXUAL DIMORPHISM.—The antennæ of the male are perceptibly longer than those of the female (Heinemann).

COMPARISON OF N. POMELLA WITH ITS ALLIES.—*N. pygmaeella* has more finely scaled, and more shiny anterior wings than *N. pomella*, is of an ashy-grey colour, towards the tip rather of a bluish-violet, and the cervical tuft is whitish. Of the remaining red-headed unicolorous Nepticulids, *N. oxyacanthella*, *N. desperatella* and *N. aucupariae* are much smaller, and have shorter antennæ. *N. oxyacanthella* comes nearest in colour, but the colour of the anterior wings is much brighter blue, especially towards the apex; the cilia are greyish black; the very small, often scarcely perceptible, cervical tuft is whitish instead of yellow, and the middle tibiæ are only a little paler. *N. desperatella* has no pale cervical tuft; the anterior wings are much smoother, with finer scales, as though polished, coppery-brown, or brownish, or greenish-bronze, entirely without violet or blue. In *N. aucupariae*, the large cervical tuft is whitish; the anterior wings are smoother and more finely scaled, olivaceous, only with a violet gloss towards the tip. *N. ruficapitella* and *N. aeneella* have also the cervical tuft more whitish, and the ground colour of the anterior wings greener. In the last-named species, the violet tint is wanting, or, at least, much fainter; in *N. ruficapitella* it is much brighter at the apex of the wing" (Heinemann).

Egg-laying.—The egg is deposited on the underside of an apple-leaf.

Mine.—As soon as the larva is hatched, it mines into the upper layer of the leaf, usually towards the base, forming a slender gallery, which turns pink, and betrays the presence of a larva before it is visible to the naked eye. The gallery is frequently near a vein of the leaf. As the mine becomes wider it changes to an orange-colour, with an irregular track of brownish excrement. It is never very conspicuous from above, but quite invisible on the underside. In the last portion of the mine, the larva doubles back on its previous course, and forms a blotch. The mines are usually more abundant on the lower branches of an apple tree, a single leaf sometimes having as many as a dozen larvæ in it. Frey writes: "Die Mine im Apfelblatt ist leicht zu erkennen und mit keiner einer anderen hier wohnenden Art zu verwechseln. Sie nimmt als ein ungewöhnlich kurzer, feiner Gang meistens mehr in der Mitte des Blattes ihren Ursprung und erweitert sich dann plötzlich zu einem unregelmässig rundlichen Fleck von gelbbrauner Farbe. Die braunen Kothmassen bilden eine etwas breitere Linie" (*Linn. Ent.*, xi., p. 372). Nolcken writes: "Two mines from Heinemann are rust-yellow, in the older parts rust-brown and mostly bounded by the leaf-ribs. At first the mine follows a stronger rib or is tortuous (the windings lying close together, and occupying a small space in the angle of two ribs); the frass line is bounded (but not sharply) with pale, often interrupted, narrow margins, and is, in the latter part of the mine, always more broken and irregular, dividing into little heaps of grains towards the end. Here it is probably 2·5 mm. broad, but since it is very much twisted in a short space, it frequently crosses and absorbs an earlier portion of the mine. The larva, too, shows a tendency when feeding to eat the parenchyma for a considerable distance on either side of its head, and this widening of the mine allows the excrement pellets to be arranged in longer curves than can occur in a narrow and more direct mine. The mine occasionally takes on the blotch or blister form, owing to the walls between neighbouring windings being eaten away, but this is by no means uniformly the case."

Larva.—The larva is orange coloured, with the dorsal vessel slightly darker, the skin shiny, the head pale chestnut (Vaughan). It mines with the dorsum uppermost.

Cocoon.—The cocoons average 2·9 mm. long and 2·1 mm. wide. They are considerably broader at one end than the other, and more flattened at the wide end (giving the idea of the shape of a mussel-shell to the naked eye). The colour varies from orange-brown to deep red-brown. The projecting rim at the wider end is more orange-brown than the raised portion, and is characterised by a number of projecting points, by which the cocoon has evidently been fastened to some object, as silken threads extend therefrom. The surface of the cocoon is covered with minute pits, and its upper surface is domed (not flattened); a little white flossy silk is scattered over the surface. [Described June 14th, 1898, under a two-thirds lens, from cocoons sent by Dr. Wood.] Vaughan writes: "The full-fed larva leaves the leaf in which it has fed, by the upper side, and spins its cocoon in a cranny, or on the surface of the ground. The cocoon itself varies in colour, from dark chestnut-brown to bright orange: it is broader at one end ('mussel-shaped'), and has a brightly coloured rim around the upper edge, which gives it a striking appearance. The pupa protrudes itself on the emergence of the imago." Frey notes: "The cocoon is elongated, rounded, and pale reddish-brown in colour." Heinemann describes it as "oval, rather flat, and of a reddish-brown colour."

Food-plant.—*Pyrus malus.*

Time of appearance.—The species is double-brooded, the imago appearing in May and August, from larvæ that feed up in October-November, and July respectively. The July larvæ appear to be scarcer than those of the October-November brood (Vaughan). Hind says that at York, mines are common from October to December, and that the imagines emerge in June or commencement of July, flying at sunrise; the species there appears to be single-brooded. Vaughan bred imagines between April 6th-8th, 1859. Fletcher says that in Sussex "the species is distinctly double-brooded, the summer brood is rarer and the specimens smaller than the autumnal brood" (*in litt.*).

Localities.—Cambridge: Cambridge (Farren). Dorset: Purbeck, Weymouth (Bankes), Glanvilles Wootton (Dale), Bloxworth (Cambridge). Essex: Wanstead (Elisha). Gloucester: Bristol (Vaughan). Hereford: Tarrington (Wood). Kent: Lewisham (Stainton). Lancashire: Preston and Grange (Threlfall). Sussex: Bersted Mundham, Bognor, Worthing, Chichester, abundant in leaves of garden apple (Fletcher), Guestling (Bloomfield). Yorkshire: Richmond (Sang), Scarborough, on crab apple (Wilkinson), York (Hind).

Distribution.—France: Nohaut, Indre (Sand). Germany: Alsace (Peyerimhoff), Brunswick, Hanover, Frankfort-on-the-Main (Heinemann), Brandenburg, Potsdam, Friedland, Hamburg, nr. Stettin, Liegnitz (Sorhagen). Netherlands: not common, Friesland, Arnhem, Gelderland, Rotterdam (Snellen). Russia: Maandja (Nolcken), South-west Russia, St. Petersburg (Wocke). Switzerland: nr. Zürich (Frey).

NEPTICULA PYGMÆELLA, Haworth.

Synonymy.—Species: *Pygmaeella*, Haw., "Lep. Brit.," pt. iv., p. 586 (1828); Sta., "Ins. Brit.," p. 298 (1854); "Nat. Hist. Tin.," i., p. 148, pl. v., fig. 1 (1855); "Man.," ii., p. 431 (1859); ? H.-Sch., "Sys. Bearb.," v., p. 348* (1855); Staud. and Wocke, "Cat.," etc., p. 335 (1871); Nolcken, "Lep. Fn. Est.," p. 755 (1871); Hein. and Wocke, "Schmett. Deutsch.," p. 729 (1877); Sand, "Cat. Lep. Auv.," p. 200 (1879); Peyer., "Cat. Lep. Als.," 2nd Ed., p. 163 (1882); Snellen, "Vlinders," etc., ii., p. 978 (1882); Sorhagen, "Die Kleinschmett. Brandenburg," p. 344 (1886); Meyrick, "Handbook," etc., p. 714 (1895). *Perpygmaeella*, Dbdy., "List.," 1866, p. 36; Porritt, "List York. Lep.," p. 170.

Original description.—*Tinea* (The least Pygmy) alis antice pallide auratis, capite rufescente. Expansio alarum $1\frac{3}{4}$-$2\frac{1}{2}$ lin. Proculdubio minima omnium Lepidopterorum quæ unquam vidi. Præcedenti (*ruficapitella*) forte indistincta at duplo minor, minus aurata, margine ipso postico solum obsolete purpurascente. Caput rufum seu ferrugineum. β. Capite albido, forte merè ab ætate, at alis magis auratis quam in *a.* Habitat apud Chelseiam. Imago Septis vix infrequens (Haworth, *Lepidoptera Britannica*, pt. iv., p. 586).

Imago.—Head ferruginous. Anterior wings 4-5 mm. in expanse; pale ashy-grey in colour, with a very slight violet tinge towards the apex; cilia paler grey. Posterior wings and cilia grey.

---

* Heinemann writes: "I suspect that Herrich-Schäffer's *N. pygmaeella* belongs to *N. aeneella.* It is certainly not Stainton's species, since that has pale ashy-grey anterior wings."

COMPARISON OF N. PYGMÆELLA WITH ITS ALLIES.—*N. pygmaeella* belongs to that section of the genus in which the anterior wings are unicolorous, and the pale ashy-grey colour of the anterior wings sufficiently distinguishes it from the more bronzy *N. ruficapitella*, *N. atricapitella*, *N. anomalella*, and the olive-coloured *N. viscerella*. From *N. pulverosella*, to which it bears considerable resemblance, it is distinguished by the less coarsely scaled appearance of the anterior wings (Stainton).

EGG-LAYING.—The egg is laid on the upper surface of a hawthorn leaf, either against the midrib or on the frill that edges the leaf-stalk, but, in either case, invariably on the upper surface (Wood). Stainton says on the "underside," close to the midrib, or one of the lateral ribs.

MINE.—The larva makes a small blotch in leaves of hawthorn. When the egg is laid against the midrib (and this is its most usual position) the young larva commences its mine parallel with, and close to, a rib, till it meets a transverse rib, the course of which it follows for a short distance, and then returns on its path, making a closely contorted mine, forming in the whole a blotch. The excrement of the first portion of the mine is yellowish-brown; it does not form a very slender line, nor is it placed in little arcs of circles, but it forms a moderately broad line. When the larva becomes more nearly full-grown, the excrement becomes darker, and ultimately blackish-brown. The larva comes out of the leaf to pupate (Stainton). When the egg is laid on the frill of the leaf-stalk, the newly-hatched larva mines until it reaches the blade of the leaf; the mine then runs along the edge of it, as does the mine of *N. gratiosella*, the mines of the two insects being then so similar that they can be differentiated only by the position of the egg (Wood).

COMPARISON OF THE MINE OF N. PYGMÆELLA AND N. IGNOBILELLA.—In the mine of *N. pygmaeella*, which is generally close to the mid-rib, the excrement never forms a very slender line, and is at first yellowish-brown; in the mine of *N. ignobilella*, which is frequently placed near the edge of the leaf, the excrement at first forms a very slender line (which is afterwards frequently included within the blotch-like mine), and the excrement is always black (Stainton).

LARVA.—Length 2 lines. Pale amber yellow, the dorsal vessel a little darker, and anteriorly rather greenish; the head is pale brown, the mouth and two lines receding from it darker (Stainton). It mines with the dorsum uppermost.

COCOON.—The cocoon is somewhat of the shape of a mussel-shell, of a dull pink colour. The anterior segments of the pupa are pushed out of the broader end of the cocoon before the emergence of the imago.

FOOD-PLANT.—*Crataegus oxyacantha*. Stainton gives "apple" also, evidently an error.

TIME OF APPEARANCE.—The insect is double-brooded, the imagines (which fly along hawthorn hedges in the early morning) appearing in May and August, from larvæ feeding in October and July respectively. Stainton gives August 16th, 1851, imagines flying along hawthorn hedges at 6 a.m. Bower found larvæ abundantly at Mottingham, on October 4th, 1892. Stainton bred imagines of the first brood on January 11th, 1853; April 8th and May 13th, 1853; May 25th, 1853; March 24th, April 1st and 8th, 1854; March 30th, 1855; March 25th-

28th, 1855. He also captured imagines at Lewisham, on May 15th, 1849; June 4th, 1851; May 9th, 1851. Specimens of the second brood were bred on August 1st, 1854, and captured between 6 and 7 a.m., flying in the sunshine, on August 19th, 1851; Evans records it as occurring on May 23rd, 1895, at Kirknewton.

LOCALITIES.—CAMBRIDGE: Cambridge (Farren), Newmarket (Warren). CHESHIRE: Bowdon (Edleston). DERBY: Burton (Sang). DORSET: Weymouth, Portland, common (Richardson), Isle of Purbeck (Bankes). DURHAM: Darlington (Stainton). GLOUCESTER: Bristol (Vaughan). HEREFORD: Tarrington (Wood). KENT: Lewisham (Stainton), Mottingham (Bower). LANCASHIRE: Manchester (Stainton), Grange (Hodgkinson), Liverpool dist. (Gregson), Preston (Threlfall). LINCOLN: nr. Louth (Fletcher). MIDLOTHIAN: Kirknewton (Evans). NORFOLK: King's Lynn (Atmore), Norwich (Barrett). NORTHUMBERLAND: Newcastle-on-Tyne (Stainton). SUSSEX: Lewes (Stainton), abundant on hawthorn throughout county, Arundel Park, Worthing, etc. (Fletcher), Guestling (Bloomfield). WESTMORLAND: Witherslack (Threlfall). YORKSHIRE: York (Hind), Scarborough (Stainton), Doncaster (Warren), Harrogate and Richmond (Sang), Sheffield (Doncaster).

DISTRIBUTION.—France: Nohaut, Indre (Sand). Germany: Alsace (Peyerimhoff), Brunswick (Sorhagen). Holland: not rare, and found as larvæ in autumn in many places (Snellen). Switzerland: ? nr. Zürich (Frey).

NEPTICULA VISCERELLA, Stainton.

SYNONYMY.—Species: *Viscerella*, Sta., "Zool.," 1853, 3958; "Ins. Brit.," p. 298 (1854); "Nat. Hist. Tin.," i., 126, pl. iii., fig. 1 (1855); "Man.," ii., p. 431 (1859); H.-Sch., "Sys. Bear.," v., p. 349 (1855); Frey, "Linn. Ent.," xi., p. 374 (1857); Staud. and Wocke, "Cat.," p. 336 (1871); Hein. and Wocke, "Schmett. Deutsch.," p. 733 (1877); Sand, "Cat. Lep. Auv.," p. 200 (1879); Peyer., "Cat. Lep. Als.," 2nd Ed., p. 165 (1882); Meyr., "Handbook," etc., p. 715 (1895).

ORIGINAL DESCRIPTION.—The notice in which this species was first named reads as follows: "On elm, two larvæ were distinguished, one yellow and the other green. The imago of the green one is not closely allied to any previously known species; from the gut-like appearance of its mine, Mr. Douglas has proposed for it the name of *N. viscerella*" (Stainton, *Zoologist*, 1853, p. 3958). The earliest description of the species is as follows: "*N. viscerella* (Dougl.), Sta., *Zool.*, 1853, p. 3958. Alis anticis olivaceis, postice saturatioribus; capillis luteis, fusco-mixtis. Exp. al. 2¼ lin. Head and face yellowish, intermixed with fuscous. Antennæ fuscous, basal joint whitish. Anterior wings rather of an olive tint, posteriorly darker, with whitish cilia. Posterior wings whitish-grey, with whitish-grey cilia. Appears in May (?), but not hitherto met with in the perfect state. The bright green larva mines the leaves of the elm in autumn, making the convolutions of its narrow mine so close together that they form brown blotches; it is excessively abundant in many localities (Stainton, *Insecta Britannica*, pp. 298-299).

IMAGO.—Head yellowish-fuscous. Anterior wings 5-6 mm. in expanse; olive in colour, darker towards the apex; cilia whitish. Posterior wings and cilia whitish-grey.

EGG-LAYING.—The egg is laid on the upper surface of an elm-leaf.

MINE.—The larva, on commencing its mine, deposits its excrement in a slender, dark brown line. The mine, from its commencement to its termination, is continuously contorted, not spirally, but backwards and forwards—each fresh turn fitting closely to the side of the last turn, so that no unmined portion of the leaf remains within the boundaries of the mine; after the first third of its length, the excrement is deposited in little rows of brown grains, filling up the whole width of the mine, until the larva is nearly full grown, when, sometimes, they merely form an irregular row along the centre of the mine. When the larva is full-fed, it leaves the mine to spin its cocoon (Stainton). Frey writes :—" Die Mine ist ungemein stark gewunden, und die einzelnen Windungen legen sich mit ihren Rändern dicht an einander, so dass kein Blattgrün zwischen diesen übrig bleibt. Es entsteht ein ähnliches Bild, wie es die Därme bei einer geöffneten Leibeshöhle darbieten, welches auch unserem Thiere den Namen in ganz passender Weise verschafft hat. Die Kothmassen bilden anfänglich eine feine dunkelbraune Linie, dann breite Querreihen, welche die ganze Mine erfüllen. Gegen den Ausgang hin wird die Gruppirung der Excremente manchmal unregelmässig " (*Linn. Ent.*, xi., p. 375).

Larva.—Length 2 lines; green, with the dorsal vessel darker; head green, with the mouth, and two slender lines receding from it, reddish (Stainton). It mines with the venter uppermost.

Cocoon.—The cocoons average 2·75 mm. long and 2 mm. wide. They are of a pale yellow-brown colour, ovate in outline, the empty pupa-skin projecting from the rather broader end. There is no strongly marked rim, the raised central part sloping up almost from the outer margin, and after forming somewhat of a dome, becoming considerably flattened on the top. The cocoon proper shows a slightly roughened, woven surface, with a few loose, flossy, white silken fibres attached to its outer surface. [Described under a two-thirds lens, June 14th, 1898, from cocoons sent by Dr. Wood.] Stainton says: " The cocoon is oblong, oval, dull, dark, greenish-brown. In this the larva remains for a considerable period (perhaps in a natural state until the following spring) before changing to a pupa. The anterior segments of the latter are protruded from the cocoon before the emergence of the imago."

Pupa.—The empty pupal skin protrudes from the cocoon to about the 3rd or 4th abdominal segment; the antennæ, legs, etc., are only partly withdrawn. The former show the segmentation very distinctly. The pupal skin is quite transparent and exceedingly delicate, the 1st abdominal segment appears to be darkened dorsally with blackish-grey pigment.

Food-plant.—*Ulmus campestris.*

Time of appearance.—The insect is single-brooded, appearing in nature at the end of May and in June, from larvæ occurring in September-October. Stainton bred specimens on the following dates: December 7th, 16th and 26th, 1852, January 17th, June 6th, 1853, April 9th, 15th, 18th, 19th, 27th, 30th, May 1st, 20th, June 2nd, 3rd, 1854. Sang took larvæ on September 18th, 1873, at Richmond, and September 24th, 1874, at Woodside; Bower found mines on October 3rd, 1892, and September 26th, 1895, at Lewisham.

Localities. — Cambridge: Cambridge (Farren). Cheshire: Bowdon (Edleston). Devon: Dawlish (Stainton). Dorset: Purbeck (Bankes), Weymouth (Richardson). Durham: Darlington (Stainton). Essex: Wickham Bishops (Cansdale). Gloucester: Bristol (Stainton). Hereford: Tarrington (Wood). Kent: Lewisham (Bower), Norwood, West Wickham (Stainton), Woodside (Sang). Suffolk: Tuddenham (Warren). Sussex: common in hedgerows at Goring, Arundel, Worthing, Eastbourne and Bramber (Fletcher). Yorkshire: Richmond (Sang).

Distribution.—France: Nohaut, Indre (Sand). Germany: Alsace (Peyerimhoff), Central and Western Germany (Wocke), Frankfort-on-the-Main (Heinemann), Pomerania (Hering).

NEPTICULA AUCUPARIÆ, Frey.

Synonymy.—Species: *Aucupariae*, Frey, "Linn. Ent.," xi., p. 376 (1857); Hein., "Wien. Ent. Monats.," vi., pp. 241, 247 (1862); Staud. and Wocke, "Cat.," p. 336 (1871); Nolcken, "Lep. Fn. Est.," p. 761 (1871); Snellen, "Tids. v. Ent.," xvi., p. 34 (1873); Hein. and Wocke, "Schmett. Deutsch.," p. 735 (1877); Sand, "Cat. Lep. Auv.," p. 200 (1879); Peyer., "Cat. Lep. Als.," ii., 2nd Ed., p. 165 (1882); Snellen, "De Vlinders," ii., p. 980 (1882); Warren, "Ent. Mo. Mag.," xxii., p. 131 (1885); Sorhagen, "Die Kleinschmett. Brandbg.," p. 303 (1886); Meyrick, "Handbook," etc., p. 715 (1895).

Original description.—Capillis ochreis, antennarum conchula dilute flavida; alis anterioribus fusco-æneis, subnitidis, apicem versus saturate violaceis, ciliis griseis. ♀ $2\frac{1}{3}'''$. Es ist allerdings ein Wagniss, in einer so schwierigen Abtheilung der Nepticulen, wie es gerade die uns jetzt beschäftigende ist, nach einem Exemplare eine neue Art aufzustellen. Indessen glaube ich hier meiner Sache sicher zu sein. Bei uns in Zürich sind im September und noch in den ersten Oktobertagen die Blätter der Sorbus-Gesträuche, wie sie hier und da in den Bergwäldern vorkommen, mit zahlreichen Gängen einer grünen Nepticularaupe minirt, deren Erziehung aber verzweifelt schwierig ist, wie ich denn aus ganzen Schaaren der Larve zur Zeit nur ein einziges weibliches Stück erhalten konnte. Gesicht und Schopf heller als bei *N. viscerella*, licht ochergelb. Die ziemlich ansehnlichen Augendeckel erscheinen ebenfalls lichter gelb, mehr gegen das Weissliche ziehend; die Fühlergeisel ist schwärzlich. Die Taster weisslich. Das Rückenschild ist tief olivenbraun, erzartig erglänzend. Leib schwärzlich, Beine braungrau, die Hintertarsen etwas lichter. Dieselbe Grundfarbe, wie der Rückenschild, zeigen die etwas breiten Vorderflügel, welche sich durch ihren Glanz leicht von denjenigen der *N. viscerella* unterscheiden lassen und auch eine viel feinere Beschuppung besitzen. Gegen ihr letztes Viertheil erglänzen die Vorderflügel sehr lebhaft violett. Die Franzen stark hellgrau, doch etwas weniger hell als bei *N. viscerella*; auch hier sind sie am Afterwinkel viel dunkler. Hinterflügel und ihre Franzen mässig dunkelgrau . . . . . Bisher nur von Zürich, wo ich das Exemplar im Februar, 1856, im geheizten Zimmer erhielt (Frey, *Linnaea Entomologiea*, xi., pp. 376-377).

Imago.—Head yellowish. Anterior wings 4·5 mm. in expanse; bronzy or olive-brown in colour, tinged with violet towards the apex; cilia grey. Posterior wings and the cilia pale grey.

Comparison of N. aucupariæ with N. viscerella.—The head and face are paler in *N. aucupariae* than in *N. viscerella*, being of a light ochreous yellow tint; the rather conspicuous eye-caps also appear lighter yellow, approaching rather to whitish; base of antennæ blackish; palpi whitish. Thorax deep olive-brown, with metallic lustre. Abdomen blackish; legs grey-brown; hinder tarsi slightly lighter. The fore-wings, which are rather broad, have the same ground-colour as the thorax, and may easily be distinguished from *N. viscerella* by their lustre, possessing, as they do, a much finer scaling. Towards the apex they shine with a very bright purple gloss (Frey).

Comparison of N. aucupariæ with N. nylandriella, etc.—Warren pointed out (*Ent. Mo. Mag.*, xxii., pp. 132-133) that this species and *N. nylandriella* were mixed in collections, the larger specimens with purplish apex being referable to *N. aucupariae*, Frey, the smaller and unicolorous ones agreeing with *N. nylandriella*, Teng. Stainton says that *N. aucupariae* can be distinguished from *N. minusculella* by its yellow head.

EGG-LAYING.—The egg is laid on the underside of a leaf, and is difficult to find (Nolcken).

MINE.—The mine of this species is very different from that of *N. sorbi*, which latter, commencing with a slender gallery, terminates in a complete blotch; the mine of *N. aucupariae* bears much resemblance to that of *N. viscerella*, but often runs along the margin of the mountain-ash leaf, going in and out of the serrations (Stainton). A mine, supposed to be of this species, taken at West Wickham, followed the serrations of the leaf, with the excrement not forming so dark nor so continuous a track as in *N. oxyacanthella*. Nolcken says: "The mine is at its commencement exceedingly fine, and only very slowly increases in width. It is, however, exceedingly long, and more or less tortuous in character. The character of the frass line varies. In the first part of the mine it forms a slender line that appears to fill up the greater part of the mine, showing, however, very fine margins, that are only a little lighter than the rest of the surface of the leaf. Later, the frass is more distinctly grained, and forms tiny transverse arcs, which, however, sometimes run into one another. At times the frass entirely fills up the mine with scattered grains, at other times the pellets occupy the middle of the mine, frequently forming a narrow stripe (generally at the end of the mine), leaving a free margin of varying width, sometimes only on one side. Frey writes: "Die Mine beginnt mässig fein mit dunkelbrauner Kothlinie, wird dann ungefähr ebenso breit als bei *N. viscerella* und zeigt die Excremente in denselben, den Rand des Ganges erreichenden Querreihen. Sie ist für die Grösse des Falters sehr lang und läuft meistens den zackigen Rand des Blattes entlang. Die Ausgangsöffnung ist kaum verbreitert."

LARVA.—Frey writes: "Die Raupe, 2‴ messend, ist grasgrün und an diejenige der vorigen Art (*N. viscerella*) erinnernd. Ebenso ist die Mine nicht unähnlich und oft sehr stark gewunden." Nolcken also states that "the larva is of a distinct, grass-green colour, with only slightly darker dorsal vessel, pale brownish head, with the sutures and mouth-parts darker."

COMPARISON OF THE MINE AND LARVA OF N. AUCUPARIÆ WITH THOSE OF N. SORBI.—Like that of *N. aucupariae*, the mine of *N. sorbi* also begins as a very fine and tortuous gallery, but it has a stronger and more conspicuous black frass-line, and enlarges suddenly into a large brown blotch with light, rust-yellow markings; its larva is also almost colourless, pale greenish. The latter is accordingly easily to be separated from the larva of *N. aucupariae*, which is more intensely grass-green, with scarcely darker dorsal vessel and very pale brownish head, of which only the mouth-parts and sutures are darker brown. The somewhat flat, oval cocoons are brown, more or less yellowish (Nolcken).

COCOON.—The cocoon is nearly round, flattened and smooth, deep reddish-brown in colour (Frey).

FOOD-PLANT.—*Pyrus aucuparia.*

TIME OF APPEARANCE.—The species appears to be single-brooded (Sorhagen makes it double-brooded, flying in May and August), the imago appearing in May and June. Wilkinson bred it on May 23rd, 1862, at Scarborough, and Griffith captured imagines on Betty Hill, Sutherlandshire, on June 3rd, 1885. The larva was common in the leaves of mountain-ash from September 1st-October 12th, 1891, at Richmond, Yorkshire (Bower). It also occurs in these months in Switzerland, although the first specimen of the species observed emerged in Frey's room, in February, 1856. Sang found mines on September 1st, 1856, at Harrogate; October 7th, 1857, and September 29th, 1871, October 9th, 1873, September 28th, 1878, at Barnard Castle; September 12th, 1873, at Stanhope; October 2nd, 1878, October 7th, 1879, at Richmond, Yorks.

LOCALITIES.—CHESHIRE: Bowdon (Edleston). DURHAM: Barnard Castle, Stanhope, High Force (Bower). HEREFORD: Tarrington (Wood). LANCASHIRE: Preston and Grange (Threlfall). LEICESTER: Market Harborough (Matthews), Whitwick (Sang). NORFOLK: King's Lynn, rather common (Atmore). SUTHERLAND: Betty Hill (Griffith). WESTMORLAND: Witherslack and Windermere (Hodgkinson). YORKSHIRE: Richmond (Bower), Ingleborough (Bankes), Doncaster (Corbett), Scarborough (Wilkinson), Harrogate (Sang).

DISTRIBUTION.—France: Nohaut, Indre (Sand). Germany: Sandsee, Alt Damm, Friedland (Hering), Alsace (Peyerimhoff), Brunswick, Silesia (Heinemann), Brandenburg, Hanover (Sorhagen). Netherlands: Friesland (Snellen). Russia: Livonia (Sorhagen), Pichtendahl (Nolcken). Switzerland: Zürich (Frey).

NEPTICULA MINUSCULELLA, Herrich-Schäffer.

SYNONYMY.—Species: *Minusculella*, H.-Sch., "Sys. Bear.," v., p. 348 (1855); Frey, "Die Tineen," etc., p. 373 (1856); "Linn. Ent.," xi., p. 377; Sta., "Nat. Hist. Tin.," vii., p. 162, pl. viii., fig. 1 (1862), "Ent. Ann.," 1870, p. 159; Staud. and Wocke, "Cat.," p. 336 (1871); Hein. and Wocke, "Schmett. Deutsch," p. 735 (1877); Sand, "Cat. Lep. Auvergne," p. 200 (1879); Peyer., "Cat. Lep. Alsace," 2nd Ed., ii., pp. 165-166 (1882); Snellen, "Vlinders," etc., ii., pp. 979 (1882); Sorhagen, "Die Kleinschmett. Brandenburg," p. 303 (1886); Meyrick, "Handbook," etc., p. 715 (1895).

ORIGINAL DESCRIPTION.—*N. minusculella*. Magnit. 4; cilia non squamiformia; capilla foeminæ olivaceo-fusci, lateribus sordide lutei. Vierte Grosse, Franzen ohne Auszeichnung, die Kopfhaare des Weibchens in der Mitte olivenbraun, ausserden schmutzig lehmfarben. Eine der kleinsten *Tineinen*, in den Farben der vorigen gleich, aber die Schuppen der Vorderflügel viel gröber, daher weniger glänzend, gegen die Spitze kaum kupferig. Die Franzen nicht weisser, Fühler schwarz, Augendeckel und Nackenschöpfe weiss. Kopfhaare schwarz, beim Weibe mit olivengrünlichem Lehmgelb unten und seitlich stark gemischt, in der Mitte mehr olivenbraun als schwarz. Im Mai und Juni an Birnbäumen, funf Exemplare. Von H. Dr Wocke, in Breslau. (Herrich-Schäffer, *Sys. Bear. der Schmett. von Europa*, v. (1855), p. 348).

IMAGO.—Head black; anterior wings 4-5 mm. in expanse, rather narrow; shiny, pale bronzy-green, with a faint purple tinge at apex; cilia scarcely paler than the ground-colour of the wings. Posterior wings and cilia dark grey.

COMPARISON OF N. MINUSCULELLA WITH N. AUCUPARIÆ, N. ATRICAPITELLA, ETC.—This species is readily distinguished by its small size and pale green colour from all its congeners except *N. aucupariae*, but that species has a yellow head; in *N. minusculella*, the head seems to be always black. It may be also readily distinguished from *N. atricapitella* by its much smaller size, narrower anterior wings, and

their paler green colour (Stainton). Frey writes: "In dem schwarzen Schopfe stimmt *N. minusculella* unter sämmtlichen vorangegangenen Arten allein mit *N. atricapitella*. Ihre bedeutende Kleinheit und die hellere bräunlichere Flügelfarbe werden jede Verwechslung unmöglich machen. Ebenso ist es näturlich unmöglich, eine der bisherigen rothköpfigen Species für *N. minusculella* zu nehmen. Dagegen könnten unter den folgenden Nepticulen, *N. anomalella* (in schwarzköpfigen Exemplaren) und *N. tiliae* zu einer Verwechslung Veranlassung geben. Von beiden aber trennt sie ihre viel mehr in das Bräunliche ziehende Flügelfarbe, ferner ihre entweder gar nicht oder kaum wahrnehmbar, höchstens äusserst leicht, violett tingirte Flügelspitze. Auch ist die Befranzung des *minusculella*-Vorderflügels dunkler" (*Linn. Ent.*, xi., pp. 377-378).

Variation.—Martini and Hering suggest that *stettinensis*, Hein., is only a variety of *N. minusculella*, H.-Sch. The original description of the latter is as follows:—

> "*Nepticula stettinensis*, n. sp. (?).—Capillis atris, penicillis et antennarum conchula albis; alis anterioribus nitidis, aeneo-plumbeis, apice violaceis, ciliis alisque posterioribus griseis. Long. 3 lin. In den weisen Nackenschöpfen mit *samiatella* übereinstimmend und auch im Uebrigen dieser Art sehr ähnlich. Kleiner, die Kopfhaare auch im Gesicht rein schwarz, während sie bei *samiatella* über dem Munde mehr oder weniger rostgelb sind, die Vorderflügel sehr glänzend, bleigrau, schwach violettblau, die Franzen au der Spitze hellgrau. Die Hinterflügel reiner hellgrau (bei *samiatella* mehr bräunlich). Auch die Unterseite der Flügel ist reiner und heller grau als bei der letzteren Art. Gleichfalls der *tiliella* ähnlich, von dieser durch kleinere Augendeckel, breitere Vorderflügel, die weniger erzgrün und vorder Spitze nich lichter sind, unterschieden. Dr. Schleich erzog ein ♀ aus Blättern des wilden Apfelbaumes" [Heinemann, *Berlin Ent. Zeits.*, xv., p. 210 (1871)].

Egg-laying.—Wood says:—"The egg is always laid on the underside of a leaf." Stainton says: "The egg is laid on the upper surface of the leaf of the pear, close to the footstalk." Probably this refers to *N. pyri*.

Mine.—The larva commences by making a long and very slender gallery, in the centre of which is a track of black excrement; when this mine is nearly an inch in length it becomes considerably broader, and then the line of excrement occupies only a small portion of the mine; the gallery is slightly contorted, but not very much so; when the larva is full fed it leaves by the upper surface of the leaf (Stainton). Wood writes: "The mine forms a wide gallery with the frass collected into the middle. It lies on the underside of the leaf, and is small and cramped. When a larva happens to be in a leaf rather thicker than usual, it contracts to some extent the width of its gallery, signs of imperfect coiling may appear, and the mine becomes somewhat similar to that of *N. pyri*." Frey writes: "Die Mine beginnt mit einem ziemlich feinen, schlanken Gang, in welchem der schwärzliche Koth die Mitte einnimmt. Dann vergrössert sich jener zu einer stark gewundenen unregelmässigen weiteren Gallerie, worin die ziemlich breit gewordene Kothlinie jedoch die braunen Ränder nicht erreicht. Nur gegen den Ausgang des Ganges hin nehmen die Excremente wieder die Form eines feineren Streifens an. Indem die ganze Mine ungewöhnlich dunkel ist, kann sie bei anfänglichem Suchen leichter übersehen werden als andere."

Larva.—Length 2 lines; green, with the dorsal vessel darker, and sometimes with a reddish tinge; head pale green, with the mouth and two lines receding from it, reddish (Stainton). The larva has a pale head, has no trace of the cephalic ganglia, and a tinge of blue in its green ground-colour (Wood). Warren records that the larvæ go through the winter, and that some he had in the autumn of 1882 did not make their cocoons until the middle of April, 1883. He considers that they hybernate on the ground. Fletcher adds: "The pear species occurring here (Worthing) agrees in its life-history with Warren's experience of 1882-1883. My larvæ came out of their mines and forthwith spun their cocoons, and so, I infer, did the larvæ described by Stainton, *Nat. Hist. Tin.*, vii., p. 164" (*in litt.*, June 12th, 1898).

Cocoon.—When the cocoon is freshly spun, in March or the middle of April, it is of a bright yellow colour (Warren). Stainton says: "The cocoon is small and greenish-brown in colour." This probably is so after the cocoon has been exposed to the weather for a time.

Food-plant.—*Pyrus communis*, prefers wild to cultivated forms.

Time of appearance.—Stainton says that the species is double-brooded, the imagines appearing in May and July, from larvæ that have fed up in August and June respectively. Wood adds that larvæ are found feeding in July, and again in September. Boyd bred specimens on February 22nd, 1869, from larvæ collected in pear leaves, at Cheshunt, in August, 1868. There are specimens in Stainton's collection, bred by Boyd, Feb. 18th and March 3rd, 1868 (? 1869). Hodgkinson bred imagines on April 17th, 1888, from mines found in October, 1887; some others also emerged on April 6th, 1889, from the same mines. Peyerimhoff says that there are three broods in Alsace, *viz.*, June, August and October, the imagines from the latter emerging in April. Frey writes: "Die kleine grüne Larve kommt in doppelter Generation vor, einer sommerlichen, von welcher die Raupen in der zweiten Junihälfte erwachsen sind, und einer sehr bald nachfolgenden herbstlichen, welche sich schon von Mitte bis Ende August zur Verpuppung anschickt." Frey further adds, that he has found the summer generation at the beginning of July, and taken the imagines of the first brood *in copulâ* at the end of May. Fletcher notes the occurrence of larvæ at Worthing, July 1st, 1898, the greater part of the mines being, however, empty on that date.

Localities.—Cambridge: Cambridge (Warren). Devon: Exeter (Parfitt). Hereford: Tarrington and Woolhope (Wood). Herts: Cheshunt (Boyd). Lancashire: Preston (Threlfall), Ashton (Hodgkinson). Sussex: Worthing and Bognor, in pear leaves, in gardens (Fletcher).

Distribution.—France: Nohaut (Sand). Germany: Hanover, ? Brandenburg (Sorhagen), Frankfort-on-the-Main (Heinemann), Alsace (Peyerimhoff), Breslau in Silesia (Wocke), Ratisbon in Bavaria (Stainton). Netherlands: Rotterdam, South Holland, Leeuwarden, Friesland, not common (Snellen). Switzerland: near Zürich (Frey).

NEPTICULA PYRI, Glitz.

Synonymy.—Species: *Pyri*, Glitz, "Jahresbericht der naturhistorichen Gesell. zu Hannover,, xiv., p. 42 (1865); Frey, "Schweiz. Ent. Gesell.," 1870, p. 289; "Stett. Ent. Zeit.," 1871, p. 123; Staud. and Wocke, "Cat.," p. 336 (1871); Sand, "Cat. Lep. Auvergne," p. 200 (1879); Sorhagen, "Die Kleinschmett. Brandbg.," p. 303 (1886); Wood, "Ent. Mo. Mag.," xxvi., p. 88 (1890) and vol. xxx., pp. 46 and 94 (1894); Hering, "Stett. Ent. Zeit.," lii., p. 219 (1891); "Stett. Ent. Zeit.," liv., p. 116 (1893); Meyr., "Handbook," etc., p. 716 (1895).

Original description.—We have been quite unable to get the original description by Glitz. There appears to be no copy of the *Jahresbericht der naturh. Gesell. zu Hannover* in the London libraries, and a reference in Sorhagen's *Die Kleinschmett. der Mark Brandenburg*, p. 303, where he writes: "Beschr. Glitz, *l. c.* 47, und *Jahresbericht*, etc., 1865, 42," suggests an earlier note. To what the "*l. c.*" refers, however, we are utterly unable to say. Frey, who describes the species in 1870, calls it "*N. pyri*, Glitz, *in litt.*" His description reads as follows: — "*N. pyri*, Glitz, *in litt.* — Der *N. minusculella*, H.-S., verwandt, aber grösser, kräftiger gebaut, mit breiteren Flügeln und anders gefärbtem Schopf. Grösse der *N. catharticella*, Sta., oder *N. tiliae*, Frey. Scheitelhaare hoch orangeroth, Augendeckel gelblichweiss; die ziemlich kurze Fühlergeisel schwärzlich grau; Taster hellgrau; Brust oberwärts tiefdunkel bronzebraun, Leib schwärzlich, Beine grau, Hintertarsen ganz hellgrau, fast grauweiss. Die über den grösseren Theil ihrer Fläche mässig erglänzenden Vorderflügel besitzen als Grundfarbe ein dunkles bronzeartiges Braun. Meistens pflegt die Wurzel dunkler als das mehr messingartig schimmernde Mittelfeld auszufallen; doch kann das Colorit des Vorderflügels bis zum Spitzentheile hin gleichartig sich zeigen. Bei gewissen Beleuchtungen erhält man einen bläulichen Glanz der Schüppchen. Ganz dunkel braunschwarz und mit sehr lebhaft blauglänzender Beschuppung erscheint aber der Spitzentheil des Vorderflügels. Die Franzen hellgrau, gegen den Afterwinkel hin dunkler. Hinterflügel und Franzen dunkelgrau" (Frey, *Schweiz. Ent. Gesellschaft*, 1870, p. 289).

Imago.—Head reddish. Anterior wings 4-5 mm.; inner two-thirds fuscous, with a golden-brown gloss, the outer third purple, the junction of the two being sharply defined and concave in outline, owing to the purple extending along both margins, especially the costal one; cilia dark grey, deeper at the anal angle. Posterior wings and cilia dark grey.

Egg-laying.—The egg is laid on the upperside of a leaf of pear, nine times out of ten (Wood).

Mine.—The mine is narrow, small and cramped, and placed either on the upper or underside of a pear leaf, with a very decided preference for the former (Wood thinks that it is due to the fouling of the upper-surface with honey-dew, that sometimes drives it to the lower surface). The convolutions show a general tendency to keep close together, but occasionally they run together so as to form a blotch, and then the frass, which is generally coiled with regularity, tends to become rather slovenly arranged.

Larva.—The larva is bluish-green in colour; the head very pale; the hind portion of the abdominal canal red; the cephalic ganglia and ventral cord invisible; legs well developed. The larva mines with its dorsum upwards. Both the larva and the mine are with difficulty to be distinguished from those of *N. oxyacanthella*. The red intestinal canal of *N. pyri*, however, forms a good distinction between it and the larva of *N. oxyacanthella*, which has a yellow intestinal canal. Sorhagen describes the larva as follows: "Die Raupe 9-10 und seltener 7 (Juli) in den Blättern des wilden und cultivirten Birnbaums, in jenem häufiger. Gangmine schwach gewunden, anfangs sehr fein, in den 2 letzten Drittheilen breiter, mit der Kothlinie in der Mitte."

Comparison of the mines of N. pyri and N. minusculella.—It is not always easy to discriminate between the mines of *N. pyri* and *N.*

minusculella. If the mines are typical no difficulty arises, but occasionally the convolutions in *N. pyri*, which always show a tendency to keep close together, will so run into each other as almost to form a blotch, and at the same time the coiling of the frass gets rather slovenly. On the other hand, when *N. minusculella* happens to be in an over-thick leaf, and in consequence contracts to some extent the width of its gallery, signs of imperfect coiling may show themselves, probably an ancestral habit, indicating that the insect has only recently parted company from the species that use narrow galleries, and the coil arrangement. Under these circumstances, each mine encroaches somewhat on the character of the other, and their distinction becomes not as clear as could be wished. It is, therefore, rather tantalising that we should be in sight, though not quite in possession of, a very simple character, that would solve the matter at once. I mean the position of the egg; for did *N. pyri* always lay on the upperside of the leaf, as *N. minusculella* does on the underside, nothing more would be wanted, but since it does not do so, it is only in a limited number of cases, that is, where the egg is found above, that any conclusion from its position can be safely drawn (Wood).

Cocoon.—The cocoon examined measures 2·2 mm. in length, and 1·9 mm. at its widest part. It is dark red-brown in colour, with a purplish hue, and a number of darker reticulations. It is of the shape that has been described as something like a "mussel-shell" (but which appears in this instance more of the shape of a plum-stone), somewhat flattened at the broader end, yet without forming a distinct flange or rim. The narrow end is much thicker, and more rounded, whilst along this and one of the long sides the dome-shaped top rises from the edge without the flattening of the two opposite sides. The cocoon examined has no flossy silk hanging about it, except along the outer rim, where some fibres show that it has been attached by the outer edge. [Described under a two-thirds lens on June 20th, 1898, from a cocoon sent by Dr. Wood.] Wood notes the cocoon as being "very like that of *N. oxyacanthella*, but smaller and darker. It is also placed in similar situations."

Food-plant.—*Pyrus communis*.

Time of appearance.—The species is double-brooded, the imagines first appearing at the end of May and commencement of June, and afterwards in August, from larvæ found feeding in September-October and July respectively. Mines collected at the end of September, 1888, produced imagines early in June, 1889 (Wood). Frey writes:—"Herr Glitz in Hannover, bekanntlich einer unserer ausgezeichnetsten Forscher, überschickte mir vor einigen Jahren mehrere Exemplare dieser neuen, von Birnbäumen erzogenen Art. Ich fand dann bei Zürich in der ersten Octoberhälfte zahlreich an wildern Birnen unter jüngeren Nadelbäumen die der von *N. minusculella* gleichende Mine mit einem ganz ähnlichen dunkelgrünen Raupchen und erzog einige den Glitz-'schen identische Exemplare. Ob die Generation eine doppelte ist vermag ich noch nicht anzugeben" (*Stett. Ent. Zeit.*, 1871, pp. 123-124).

Localities.—Hereford: Tarrington, where the species is limited to those orchards which are situated on the limestone, or on the brashy cornstones of the Old Red Sandstone (Wood).

Distribution.—France: Nohaut (Sand). Germany: Very common at Königsthor, Alt Damm, Friedland (Hering), Breslau, Hanover (Sorhagen), Grunstadt (Eppelsheim).

NEPTICULA OXYACANTHELLA, Stainton.

SYNONYMY.—Species: *Oryacanthella*, Sta., "Ins. Brit.," p. 298 (1854); "Nat. Hist. Tin.," i., p. 200, pl. v., fig. 2 (1855); "Man.," ii., p. 431 (1859); H.-Sch., "Sys. Bear.," v., p. 349 (1855); Frey, "Die Tineen," etc., p. 372 (1856); "Linn. Ent.," xi., p. 373 (1857); Nolcken, "Lep. Fn. Estland," etc., p. 762 (1871); Staud. and Wocke, "Cat.," p. 336 (1871); Sand, "Cat. Lep. Auvergne,' p. 200 (1879); Snellen, "De Vlinders," etc., p. 977 (1882); Peyer., "Cat. Lep. Alsace," 2nd Ed., ii., p. 166 (1882); Sorhagen, "Die Kleinschmett. Brand.," p. 303 (1886); Meyrick, "Handbook," etc., p. 716 (1895). *Oxyacanthaecolella*, Dbdy., "List," p. 36 (1859); Porritt, "List Yorks. Lep.," p. 170 (1886).

ORIGINAL DESCRIPTION.—*N. oxyacanthella*, n. sp. Alis anticis fuscis purpureo-tinctis, postice purpureis; capillis luteis. Exp. al. 2½ lin. Head and face deep yellow. Palpi whitish. Antennæ dark fuscous, with the basal joint whitish. Anterior wings fuscous, tinged with purple, beyond the middle almost entirely purple. Posterior wings pale grey, with pale grey cilia. Appears in May, but not hitherto observed in the perfect state. The bright green larva is very common in hawthorn leaves in autumn, making long galleries; it mines also, I believe, in the leaves of wild apple (Stainton, *Insecta Britannica*, p. 298).

IMAGO.—Head deep yellow. Anterior wings 5-6 mm.; fuscous tinged with purple, almost entirely purple beyond the middle of the wings; cilia purplish-grey. Posterior wings and their cilia pale grey.

EGG-LAYING.—The egg is laid on the underside of a leaf of hawthorn, frequently close to the midrib, and, as a rule, not very far from the petiole.

MINE.—The bright green larva of *N. oxyacanthella* makes a narrow gallery with the frass arranged in coils; the gallery usually lying on the underside of a leaf, and being long and boldly marked. Wood says: "The larva of this species coils its frass, whether the food-plant be hawthorn, pear or apple. It is noticeable, however, that, shortly before its termination, the gallery widens somewhat, and concurrently with the change, the coiling abruptly stops, and the frass is collected into a narrow central thread, showing that the larva is ready enough, when circumstances allow it, to adopt the easier and simpler method of disposal. One occasionally finds in the half-starved leaves on the butts of old hawthorn hedges, mines rather wider than usual, and with the frass running in this thread-like manner through their whole length, which makes them look very different from ordinary *N. oxyacanthella*. There is little doubt that such mines belong to this species, and I would ascribe their peculiarity to the thin and flimsy nature of the leaves." Stainton writes: "As soon as the larva is hatched it commences a very slender mine, which is filled with black-brown excrement; the larva frequently goes part of the way down the leaf-stalk, and then, turning round, returns into the leaf, when the mine becomes broader and the excrement paler, appearing merely brownish, with the grains placed in little arcs of circles not entirely filling up the mine, but leaving a very narrow margin on either side. The mine is not closely contorted, and ordinarily has not more than two or three turns, though in a very small leaf it necessarily assumes rather a different appearance." Frey writes: "Die Mine ist ein langer, mehr gestreckter und nur ein paar Mal umgebogener Gang, welcher sich nur sehr allmählig nach unten erweitert. Er wird fast ganz von der braunschwarzen, breiten, zusammenhängenden Kothreihe erfüllt, die nur gegen den Ausgang der Mine hin verfeinert aufhört. An der Ausgangsöffnung ist der Querdurchmesser des Ganges etwa 1‴."

LARVA.—Length 2 lines; bright green, the dorsal vessel darker, head green, with a faint brownish tinge, the mouth, and two lines receding from it, light brown (Stainton). The head of the larva is dark (usually dark grey or black), and is always conspicuous in the mine. The ground-colour of the larva is green, of a rather less bluish tint than that of the larva of *N. gratiosella*, and the cephalic ganglia are just visible behind the head (of these there is no trace in the larva of *N. gratiosella*). The intestinal canal is yellowish, and by this the larva can at once be separated from that of *N. pyri*. Frey writes: "Die Raupe ist, etwa 2‴ messend, lebhaft grasgrün mit dunkel hindurchschimmerndem Darmkanale. Der Kopf zeigt sich bräunlich, die Mundtheile braun." The larva mines with its dorsum uppermost in the mine.

COMPARISON OF THE MINES AND LARVA OF N. OXYACANTHELLA WITH THOSE OF N. PYRI AND N. MINUSCULELLA.—These three species make gallery mines in the pear. *N. oxyacanthella* and *N. pyri* make narrow galleries with the coil arrangement, *N. minusculella* a wide gallery with the frass collected into the middle. All have bright green larvæ; *N. oxyacanthella* and *N. minusculella* lie on the underside, *N. pyri* on either the upper or underside, but with a very decided preference for the former, and I am inclined to think that it is the fouling of the upper surface with honey-dew that generally drives it to the lower one. *N. oxyacanthella* can be recognised by its long and bold mine, by the dark head of the larva with the cephalic ganglia just visible behind, and by the yellowish intestinal canal—the characters, in fact, that distinguish it when feeding in hawthorn leaves. The mines of the other two are small and cramped; the larvæ have pale heads, and no trace of the cephalic ganglia, a tinge of blue in their ground colour, and the hinder part of the intestinal canal in *N. pyri* red. Seldom can any hesitation be felt in distinguishing *N. oxyacanthella* from *N. pyri*, and still less from *N. minusculella* (Wood).

COCOON.—The cocoon is oval, dull greenish-brown, inclining to yellowish-brown at the wider end, through which the pupa protrudes its anterior segments previously to the emergence of the imago (Stainton). Hind calls the colour of the cocoon "purplish-brown." It is usually spun on the surface of the ground, and is smooth and dark brown in colour (Wood). Frey writes: "Der Cocon ist braun, ziemlich regelmässig und länglich rund."

FOOD-PLANTS.—*Crataegus oxyacantha*, *Pyrus malus*, *P. communis*, *P. aucuparia* and *Cotoneaster affinis* (Fletcher).

TIME OF APPEARANCE.—The imago appears in May and August, from larvæ collected in September-October and July respectively. The insect is distinctly stated by Wood to be single-brooded, the larva to be found only in September and October at Hereford, the imago appearing in June. Bower records mines found October 3rd, 1891, at Lewisham, on hawthorn, and on October 3rd, 1892, at Mottingham, on apple. Stainton took the imago at Dartford Heath, on June 22nd, 1852, and from pupæ kept in confinement bred imagines on June 23rd, 1852, March 12th, 23rd, May 3rd, 5th, 1853, April 6th and 9th, and

May 15th, 1854. Nolcken found larvæ September 22nd-October 10th, 1865, at Pichtendahl, and Fologne records full-fed larvæ on June 7th, 1860, at Brussels.

Localities.—Berks: Reading (Hamm). Cambridge: Cambridge (Warren). Cheshire: Birkenhead (Stainton), Bowdon (Edleston), Tranmere (Brockholes). Derby: Burton (Sang). Dorset: Purbeck (Bankes), Bloxworth (Cambridge), Glanvilles Wootton (Dale), Weymouth (Richardson). Dublin: Howth and Coolock (Birchall). Durham: Darlington (Stainton). Gloucester: Bristol (Stainton). Hereford: Tarrington (Wood). Kent: Lewisham and Dartford Heath (Stainton), Charlton (Douglas), Mottingham (Bower). Lancashire: Manchester (Stainton), Grange (Hodgkinson), Preston (Threlfall). Lincoln: Louth, Alford (Fletcher). Norfolk: Merton (Barrett), King's Lynn (Atmore). Renfrew: Renfrew (Scott). Suffolk: Tuddenham (Warren). Sussex: common in the county (Fletcher). Westmorland: Witherslack (Threlfall). Yorkshire: Doncaster (Warren), Richmond (Sang), Scarborough (Stainton), York (Hind).

Distribution.—Belgium: nr. Brussels (Fologne). France: Nohaut, Indre (Sand). Germany: Frankfort-on-the-Main (Mühlig), Hamburg (Sorhagen), Alsace (Peyerimhoff). Netherlands: generally distributed and not rare (Snellen). Switzerland: Zürich (Frey).

NEPTICULA ANOMALELLA, Göze, AND NEPTICULA FLETCHERI, n. sp.

Under the name *N. anomalella*, Göze, there appear to have been for about a hundred and fifty years two distinct species united. These may, for convenience, be called the "red-headed" species = *anomalella*, Göze, and the "black-headed" species, for which we propose the name *fletcheri*, in compliment to Mr. W. H. B. Fletcher, who has at last separated the two forms. He writes of these: (1) The "red-headed" form occurs everywhere, it seems, in wild roses, *Rosa canina* and *R. rubiginosa*, in hedgerows, and in sundry species of garden roses, *e.g.*, I have met with it in *R. indica* var. *rugosa* rarely, in *R. sempervirens* in swarms, and in the ordinary "H. P." and "tea" roses. (2) The "black-headed" form is very common, but not so ubiquitous as the previous form. I find it here and in Lincolnshire, in *Rosa arvensis*. It is a much more covert-loving species than the other (*R. arvensis*, has, of course, the same habit). Comparing the two forms he notes: (1) The frass seems to be more diffusively disposed in the mine of the "black-headed" form; in the "red-headed" form it looks to the naked eye like the line drawn with a ruling-pen. (2) The difference in the colour of the head of the imagines is not sexual. I have a long, carefully sexed series (50-60 specimens) of each. (3) The "black-headed" form is decidedly the smaller. (4) I can breed the "red-headed" form pure in any quantity, and I think I can also breed the "black-headed" form quite pure (*in litt.*). In the *Zoologist*, vol. xi., p. 3959 (1853), Stainton writes that "from the mode of mining and the colour of the cocoons, there is little doubt that two species feed on the rose, one of which has always been confounded with *N. ruficapitella* (see Lewis in *Ent. Mag.*, i., 422), but of which one sex has the tuft of the head black, was observed by De Geer, and Göze has given to his insect the name of *N. anomalella*. The other species, which I have not bred, may be the Continental *N. centifoliella*." Here Stainton possibly, unknowingly, mixes three species, two of which he considers as sexes of one species (the one that has been mixed with *N. ruficapitella*, and which Göze has called *anomalella*). We find, further, that in the *Insecta Britannica*, p. 297, Stainton refers Lewis' "red-headed," rose-feeding *ruficapitella* to *anomalella*, Göze, and his own description of the imago, on the same page, includes the two species under discussion, for he says: "Head and face bright yellow, sometimes black." He adds that it is abundant in gardens and hedges, the situation of the "red-headed" rather than the "black-headed" form. There can be no doubt that in the *Nat. Hist. Tin.*, i., p. 54, it was the former rather than the latter that he was describing. His note that, "if we examine our rose bushes in the months of July or October, we can hardly fail to observe, on some of them, that many of the leaves are marked with pale serpentine tracks, down the centre of each of which is a black line," can only possibly refer to *N. anomalella*. The "reddish-brown" mine afterwards mentioned must also belong to this species. At this time, too, Stainton was not at all clear that the "red" and "black" heads indicated the different sexes of the same species, for he says (*Nat. Hist. Tin.*, i., p. 58): "The head and face are bright yellow, in some specimens they are black, but whether this colour of the head always indicates the sex seems doubtful." He further says that "Göze refers to De Geer's figures and descriptions, and also to his own, in the *Naturforscher;* all these represent distinctly a gallery miner of the rose, of which the larva is yellow; hence with our present knowledge of the transformations of the genus, little doubt can attach that the present is the species intended" (*Ibid.*, p. 64). De Geer evidently had but one form before him, the "red-headed" one. In the first volume of the *Memoires*, p. 446 (translated by Stainton, *Nat. Hist. Tin.*, i., p. 66), we read that "in autumn, in the months of September and October, we find on the rose-trees (both on the wild sorts and those grown in gardens), leaves which are marked with brown streaks, wavy and, as it were, entwined in one another." The character "brown streaks" only refers to the mines of the "red-headed" form. Further on (*Ibid.*, p. 76) we read, "These paths, hollowed in the leaf, are of dingy brown, from their origin to nearly the half of their length; this colour is produced by the excrement inclosed therein, which occupies the whole of the interior portion; but the other half or rather more is not entirely filled with excrement; we see only all along the middle, a continuous brown streak, composed of a succession of brown excrement, which leaves on each side of the gallery an empty space, which appears whitish, because it is the colour of the epidermis of the leaf, etc." This description again can only apply to the mine of the "red-headed" form, for in no part of the mine of the "black-headed" form does the frass produce anything approaching a "streak." Only one doubtful point occurs in this description, and that is quite at the end, where De Geer says, "in the last fourth we no longer see the excrement in zigzag, it is in the form of little blackish grains placed in rows along the gallery," a character which is, perhaps, more characteristic of the "black-headed" form. Still, on the whole, there can be no question that the description of the mine was taken from that made by the "red-headed" form. De Geer says, "the cocoons are oval and white, in some the white inclines to yellow." Fletcher sends us one perfectly white cocoon on the underside of a rose-leaf containing several mines of the "red-headed" form. It is a most unusual colour, probably due to the same disturbing influences as is the variation in the colour of the cocoons of *Saturnia pavonia*, *Eriogaster lanestris*, etc. So far as the statement and the single cocoon on the leaf are in actual agreement, the evidence supports the view of its being the "red-headed" species. De Geer describes the imago as "being of grey colour and shining, the wings furnished with a broad fringe of hairs, the antennæ filiform, and the legs long." This is of no service whatever to us. In 1774, Göze copied (*Naturforscher*, iv., pp. 1-16) De Geer's observations, but added nothing new. In 1781 Göze again described (*Ibid.*, xv., pp. 37-48, pl. ii., figs. 1-2, 8-12) the species in more detail. On p. 46 we read: "Kopf, *a*, ganz buschicht, voll kleiner keulenförmiger Haare," etc. The fore-wings are described as "braun mattgoldgelb." The colour of the head is not mentioned, but the "very bushy" or "fuzzy" applies much better to the "red-headed" than to the black-headed form. His larvæ, too, were found on garden roses as well as *Rosa canina*. Altogether one cannot doubt that Göze and De Geer had the same species under their notice when describing, *viz.*, the one so common in gardens and hedges, and which De Geer's description satisfies us, was the "red-headed," and not the "black-headed" species. In 1783, Göze [*Ent. Beytr.* (*L.S.N.*, xii.), iii. (4), 168-9, No. 290] gave the name *Phalaena Tinea anomalella* to the species which he had described in the *Naturforscher*, xv., omitting reference to *Naturf.*, iv., but citing De Geer. In none of the authors, to which we have access, is there a description of a mine like those sent to us by Fletcher, as those of the "black-headed" species in *Rosa arvensis*. In none is a point made of the "black" head, almost all mention the head as "red," and add "or black" in brackets, as if obtained incidentally, probably in the case of Frey, Sorhagen, and others, direct from Stainton. The note (already quoted) of the latter on this point shows his doubt, and his series includes individuals captured wild. The differentiation of the "black-headed" form from the "red-headed" has never yet been worked out, and hence the geographical distribution of the former is practically unknown, both in this country and abroad. Snellen, however, writes [*Vlinders Ned. Micro.*, 982 (1882)] that "the headhairs of *N. anomalella* are bright rust-yellow, brown, or black, without signifying a sexual difference." This confirms Fletcher as to the sexes being ♂ and ♀ black, and ♂ and ♀ red. Bower also states that he has bred only the "red-headed" form from *R. canina* and different varieties of garden rose.

NEPTICULA ANOMALELLA, Göze.

SYNONYMY.—Species: *Anomalella*, Göze, "Beitr.," iii., 4, p. 168, no. 280 (1783); Sta., "Ins. Brit.," p. 297 (1854); "Nat. Hist. Tin.," i., p. 54, pl. i., fig. 2 (1855); "Man.," ii., p. 432 (1859); H.-Sch., "Sys. Bearb.," v., p. 349 (1855); Frey, "Die Tineen," etc., p. 375 (1856); "Linn. Ent.," xi., p. 379 (1857); Staud. and Wocke, "Cat.," p. 336 (1871); Nolcken, "Lep. Fn. Est.," p. 759 (1871); Wallngrn., "Bihang Vet.-Ak. Handl.," iii., p. 80 (1875); "Ent. Tids.," ii., p. 126 (1881); Hein. and Wocke, "Schmett. Deutsch.," p. 733 (1877); Sand, "Cat. Lep. Auv.," p. 200 (1879); Peyer., "Cat. Lep. Als.," 2nd Ed., ii., p. 165 (1882); Snellen, "De Vlinders," etc., ii., p. 982 (1882); Mill., "Nat. Sic.," v., p. 204 (1886); Sorhagen, "Die Kleinschmett. Brandbg.," p. 302 (1886); Wlsm., "Ent. Mo. Mag.," xxvii., p. 152 (1891); Meyrick, "Handbook," etc., p. 715 (1895). *Grisearosea*, Retz., "Gen. et Spec. Ins.," 55, 170 (1783). *Rosella*, Schrank, "Fn. Boica," ii., p. 139, no. 1890 (1802). *Ruficapitella*, Lewis, "Ent. Mag.," i., p. 422. *Anomala*, Curò, "Atti della Soc. Nat. Modena," xvi. (1883).

ORIGINAL DESCRIPTION.—290. *Anomalella*, der Hautfuss (De Geer, *Ins.*, Tom. ii., pt. i, p. 495, no. 7). Phaléne à antennes filiformes, à trompe, à ailes étroites élevées grises, d'une chenille mineuse du Rosier. *Phaléne-teigne mineuse grise du Rosier* (De Geer, Tom. i., t. 30, f. 20; t. 31, f. 13, 14, 16). La chenille une mineuse jaune à dix-huit pattes membraneuses et point de pattes écailleuses, qui mine les feuilles du Rosier en galleries (De Geer, *Uebersetzung*, i., 3 Quart., p. 41, t. 30, fig. 20; t. 31, figs. 13, 14, 16. II. Th., I. B., p. 366, no. 7, die graue Rosenblattminirmotte. *Naturforscher*, 15tes St., p. 21, t. 2, figs. 1-12, die wahre, aber unendlich kleine Phaläne der Degeerischen Raupe mit 18 häutigen Wulstfüssen) [Göze, *Ent. Beyträge*, etc., vol. iii., pt. 4 (1783), pp. 168-169]. As the name is practically given by Göze to De Geer's insect, and the latter is without doubt (as proved by the description of the mine) the "red-headed" species, we would restrict the name to that species. At the same time, it is necessary to give Göze's own description of the species that he referred to De Geer's insect. He writes of larvæ found in the middle of June, 1779: "Das Räupchen ist hoch orangegelb, ohnegefähr zwo Linien lang, und nach Proportion dicke, mit achtzehn häutigen Wulstfüssen versehen. . . . . Am Kopfe obenauf zween hornartige Striche: eigentlich ein kleines herzförmiges hornartiges Plättchen. . . . . Man kann die Nahrung in dem längs durchlaufenden Kanal noch ganz grün heruntergehen und sich fortschieben sehen. Die Exkremente sind anfänglich ein graulicher flüssiger Brey, wenn das Räupchen noch sehr klein, und nicht lange aus dem Ey gekrochen ist; werden aber mit der Zeit runde schwarze kugeln, die nicht wie bey andern, als kleine Würstchen, zusammenhangen. Wenn das Räupchen bald auskriechen will, wird es unruhig, frisst nicht mehr der Länge nach; sondern links und rechts um sich, und liegt oft krumm zusammen, wodurch seiner Wohnung ziemlich erweitert wird." . . . On the 23rd June, 1779. . . . "in ein flachrundliches fahlgelbliches Gehäuse, Fig. 1, eingesponnen. Dies die natürliche Grösse, etwan eine Linie im Durchmesser; Fig. 2, durch No. 6, Tub. A[*] meines Kompositi vergrössert. Das Gehäuse selbst war unten flach, mit weisslicher Seide angeklebt: oben konvex mit scharfen Seitenränden. In der Mitte der konvexen Fläche eine runder Spiegelfleck, durch welchen das krumm zusammenliegende Räupchen durchschimmerte." Having described the Ichneumon, Göze writes thus of the *Nepticula*: "Das aus dem flachrunden Gespinnst, Fig. 1, 2, ausgekommene Insekt, Fig. 8, in natürlicher Grösse, kaum eine Linie lang, und mit geschlossenen Flügeln, kaum eine halbe breit; Fig. 9, durch No. 4, Tub. A, vergrössert; ist eine wahre Phaläne, von ausserordentlicher Struktur des Körpers, und seiner Theile. Der Kopf, *a*, ganz buschicht, voll kleiner keulenförmiger Haare, wodurch die Augen ganz verdeckt sind. Die Fühlhörner, *b c*, besonders gestaltet: an jedem ein und zwanzig stumpfkegelförmige, fast ovalrundlichte Gelenke; bey einigen, *d e f*, scharfspitzige Ecken. Die Füsse, deren nur drey vorstanden, *g h i*, auch von eigener Beschaffenheit, alle überaus haaricht; das Fussblatt ander Vorderfüssen, *k l*, zehngliedricht, und die Glieder fast eben so, als an den Fühlhörnern. Der Schenkel, und das Fussblatt der Mittelfüsse, *m n*, wieder anders; der erstere an der einen Seite haaricht; und das letztere schlichtweg. Kralen hab'ich nicht entdecken können. Die Flügel sehr haaricht; die obern, *o p*, braun mattgoldgelb, mit vielen Schuppen, sehr schmalen Federchen, und feinen Haaren bedeckt. Die Unterflügel, deren einer, *q*, etwas vorstehet, wie eine Vogelfeder. An den Ränden herum, *r*, *s*, lauter solche Haarförmige, langstielichte, oben keulenförmige, und gespaltene, dicke beysammen gepflanzte Federn als Fig. 10. Wegen seiner Kleinheit konnt'ich ihn ohne Verletzung nicht genauer behandeln. Mir war am meisten an dem Beweise gelegen, dass es erstlich eine, aus einem Minirräupchen mit achtzehn häutigen Wulstfüssen, ganz ungezweifelt gewiss ausgekommene Phälane war; zweytens, dass sie in Farben und Bildung der Glieder von andern Minirraupenmotten ganz abwich. Und diesen Beweis hat mir die Natur, die Erfahrung, und der Augenschein gegeben" (Göze, *Naturforscher*, xv., 1781, pp. 40-46).

---

[*] "Tub. A," etc., refers to the power of the compound microscope used.

Imago.—Head bright orange-yellow, the long hairs covering the base of antennæ, which appears to be black. Anterior wings 5 mm.; bronzy, tinged with purple on costa at base; apex purplish-red; cilia dark grey at their bases, paler towards the tips. Posterior wings and cilia dark grey.

Comparison of N. anomalella with N. fletcheri.—Compared with N. *fletcheri*, the fore-wings appear to be broader in N. *anomalella*, the purple colour at the apex redder and extending over a greater area, being produced markedly in some specimens for a short distance along the costa towards the base. There is also in N. *anomalella* a tendency to the development of a patch of pale cilia quite at the apex of the fore-wings. The posterior wings and their cilia appear also to be more uniformly dark grey. Besides these characters, the red-headed N. *anomalella* is a distinctly larger insect than the black-headed N. *fletcheri*.

Egg-laying.—The egg is laid on the under-surface of a rose-leaf, close to the midrib, or (almost as frequently) against one of the large lateral veins of the leaf. It forms a complete oval in outline, has a perfectly transparent shell, with no trace of sculpturing; one end of the shell is, however, almost always yellowish in hue, the remainder of the shell colourless. There is only a slight trace of iridescence, even with a good light. In some instances the shell is packed almost full of black frass, in other cases it is practically empty.

Mine.—The mine is at first very fine, and discolours the leaf so that the track is greenish, reddish or brownish at the sides (in dried leaves, probably due to difference in the colour of the chlorophyll), with the black frass scattered along the central part of the gallery. The frass, however, soon becomes exceedingly dense, filling the whole of the space mined, and causing the mine to appear as a wavy black line, with a fine red (or brown) margin on either side. This first part of the mine is about an inch in length, and contains about three or four wavy curves in its course. The second part of the mine is much wider, and altogether is perhaps an inch and a half in length; the larva now clears out a large part of the parenchyma on either side, leaving a pale (greenish) margin on each side of the frass-line, the margin gradually increasing in width as the larva progresses; this paler area is again bounded on either side with a narrow reddish (or brownish) margin, whilst the frass still forms a dense central wavy line. At the termination of the mine the larva clears out an area about a quarter of an inch long by an eighth of an inch in width, the larva finally escaping by the upper side. [The above description was made from mines of the red-headed species in leaves of *Rosa sempervirens*]. The mine in *Rosa canina* is identical with the above, except that the red or brownish margin of the gallery in *R. sempervirens* is dark-green with a brownish tinge. Stainton writes: "The larva, as soon as hatched, bores into the leaf, and commences its irregular wavy gallery, the first portion of which is indicated by the very slender line of excrement being reddish-brown; before it has proceeded, however, above a quarter of an inch, its excrement becomes black, and can be distinctly traced as having been deposited in little arcs of circles—at first filling up the whole width of the mine, but afterwards, as from the growth of the larva the mine becomes wider, only occupying the central portion of it. When full-fed, the larva splits the upper skin of the leaf, and creeps out; and if it be the summer brood, the larva proceeds to the footstalk to spin its cocoon." De Geer writes: "The gallery does not proceed in a straight line, but makes very irregular curves. The larva mines sometimes on one side, sometimes on the other, often passing across the gallery already mined. At its origin the gallery is not thicker than a hair, but it afterwards increases in width continuously to the end where it is widest. It is of a dingy brown colour for nearly the first half of its length, the colour produced by the excrement which occupies the whole of the interior portion; the remaining portion is not entirely filled, but forms along the centre of the mine a continuous brown streak, and leaving on each side an empty space, which appears whitish, because it is the colour of the epidermis of the leaf. In the first part of the gallery the excrement forms a continuous thread; in the middle division the pellets are arranged in curves zigzagging from one side to the other; in the last division the blackish grains are placed in rows along the gallery."

Larva.—The larvæ are not more than two lines in length. They are of a yellow tint, inclining to orange, but the head is brown. The body is divided into twelve segments, and diminishes in width posteriorly; it is furnished with some very fine hairs. The transparency of the skin allows of some of the internal organs being seen. The head is furnished with two flat and slender mandibles, and is consequently well suited for gnawing and detaching the pulp of the leaf without injuring the upper cuticle; these teeth are much advanced in front of the head, and form a point. Beneath the head is a little spinneret, like a prolonged teat, very similar to that of other caterpillars. The legs are eighteen in number, placed in two rows in pairs. They are similar to the membranous legs of the larvæ of saw-flies, pyramidal or conical in shape, without hooklets, and are placed on the nine segments following the first (De Geer). Stainton's description of the larva is as follows: "Length 2 lines. Amber-yellow, shining, transparent; the dorsal vessel darker yellow; head small, piceous, lighter at the sides, leaving the centre as a dark quadrate patch; the prothorax anteriorly piceous, interrupted in the centre by a broad yellow line, and rounded posteriorly, this colouring being evidently the hinder portion of the head showing through." Wood says that the prothoracic markings are the equivalents of the two halves of a pro-thoracic plate. They are black in colour, and of unusual size, so that they project well beyond the head. The alimentary canal is characterised by its being of a green tint in front and yellow behind.

Cocoon.—The cocoons average 3 mm. long and 2·2 mm. wide. They are roughly oval in outline, and neither end is markedly wider than the other. Each is regularly domed from the edge to the centre, composed of a rather dark brown-coloured silk, becoming more yellow round the outer rim; the surface is comparatively smooth and rather shiny, there being very little loose silk noticeable, except along the somewhat crenate margin, by which the cocoon is generally attached to the under surface of a leaf. [Described under a two-thirds lens, on June 21st. from cocoons sent by Mr. W. H. B. Fletcher.] One cocoon of this species, placed on the underside of a leaflet of *R. sempervirens*, in which are the mines sent by Mr. Fletcher for description, is of a pure white colour. It is placed partly under the slightly curled margin of the leaf, and has a projecting pupa-case. There is a considerable amount of loose flossy silk and a rather broad white flange running around the outer edge. Other cocoons are testaceous, and others, again, orange-brown in colour, mostly spun on the under-side of a leaf, in the angle between the mid-rib and a lateral vein. De Geer states that he examined the branches and stems of the rose-trees, in the leaves of which he observed empty galleries, in order to find the ordinary and natural retreats of these insects. He found several enclosed in cocoons, which were generally placed in some cavity or fissure in the bark of the branches. He often found them "in the angle formed by two branches, or in the angle formed by a large thorn with the branch from which it sprung. The caterpillars choose such places because they find it easier there to fix all round their body the threads which form the cocoon; a level surface would not have been so suitable." De Geer further describes the cocoons as "oval and white. In some, the white inclines to yellow. Although their sides are thin, they are close and very strong, so that one can hardly tear them without hurting the insect they contain." Lewis describes the upper part of the cocoon as "convex and generally circular; the under part oblong, shaped to hold the pupa, and much smaller than the upper, which projects considerably beyond it on all sides." Stainton writes: "When full-fed, the larva splits the upper skin of the leaf and creeps out; and if it be the summer brood, the larva proceeds to the foot-stalk of the leaf, and there spins its orange cocoon, which is rather of a peculiar structure, for the side of it exposed to the weather is found to have a sort of outer covering, which projects beyond the limits of the actual cocoon, serving, we may suppose, as a protection from wet. If the larva be of the autumnal brood, it very rarely seeks the foot-stalk of the leaf, but attaches itself to the main stem of the rose-bush, beneath the shelter of some branch or thorn (or else it probably seeks shelter on the ground among leaves). After completing its cocoon it assumes the pupal state, in which it remains for a fortnight or three weeks in summer, and for six or seven months in winter, at the end of which time the pupa protrudes its head from one end of the cocoon, and the imago emerges."

Pupa.—The pupa is of a bright yellow-orange colour, in which the parts of the future animal are more marked than in ordinary "chrysalides," yet less so than in "nymphs." The form of the pupa is oval; the abdomen, which terminates in a truncated cone, is divided into segments; the wing-cases extend nearly to the end of the abdomen, and are of considerable breadth. The antennæ and legs are placed in regular order between the wings (De Geer).

FOOD-PLANTS.—*Rosa canina*, *R. rubiginosa*, many species of garden rose, etc. Wood states that he has also bred it from *R. arvensis*.

TIME OF APPEARANCE.—The species is double-brooded, the imagines appearing in May and August, from larvæ that have fed up in October-November, and July respectively. Bower records the mines as being obtained on October 3rd, 1892, at Lewisham. Stainton bred the species on August 24th-25th, 1853, from mines obtained at Dawlish; on May 6th, 1852, April 24th and May 17th, 1853, from larvæ obtained at Lewisham; on March 17th, May 4th and 13th, 1853, from larvæ obtained at Beckenham. Imagines were captured on June 1st, 1876, at Lewisham, and May 20th, 1851, at Beckenham. Evans records imagines on May 23rd, 1895, at Kirknewton, and June 3rd, 1895, at Greenbank; Walsingham, on April 20th, 1890, at Cannes, and in Corsica, June 12th, 1898, whilst Reuter notes it in the I. of Aland, on May 13th, 1886.

LOCALITIES.—The following localities refer indiscriminately to *N. anomalella* and *N. fletcheri*, the species not having been previously diagnosed separately. If a separation can be made before the completion of this volume, it shall be added in an appendix.

CAMBRIDGE: Cambridge (Warren). CHESHIRE: Bowdon (Edleston). DERBY: Burton (Sang). DEVON: Dawlish (Stainton). DORSET: Isle of Purbeck, Corfe Castle (Bankes), Weymouth (Richardson), Glanvilles Wootton (Dale), Bloxworth (Cambridge), Portland,* one only, bred (Bankes). DUBLIN: Howth (Birchall). DURHAM: Darlington (Sang). FLINT: Northop nr. Mold (Bankes). GLOUCESTER: Bristol (Stainton). HEREFORD: Tarrington (Wood). KENT: Tenterden, Beckenham (Stainton), Lewisham and Lee (Bower). LANCASHIRE: Manchester (Stainton), Grange (Hodgkinson), Fleetwood, Preston (Threlfall), Liverpool district (Gregson). LINCOLNSHIRE: Alford (Fletcher). MIDLOTHIAN: Kirknewton, Greenbank (Evans). NORFOLK: Myntlyn, nr. Lynn (Barrett), Merton (Walsingham), King's Lynn (Atmore). NORTHUMBERLAND: Newcastle (Stainton). SUFFOLK: Great Glenham (Bloomfield), Lowestoft (Boyd). SUSSEX: generally abundant in the county (Fletcher), Worthing (Bankes), Guestling (Bloomfield). YORK: Scarborough (Wilkinson), Richmond (Sang), York (Hind), Doncaster (Warren).

DISTRIBUTION.—Austria: Hraszt nr. Fiume (Mann), Carniola (Wocke). France: Nohaut, Indre (Sand), Cannes, Corsica (Walsingham). Germany: generally distributed and common (Heinemann and Wocke), Berlin, Potsdam, etc. (Sorhagen), Alsace (Peyerimhoff). Italy: Goriziana and Istria (Curò). Netherlands: Friesland, Leeuwarden Arnhem, Breda, Dongen, Oudenbosch, South Holland (Snellen). Russia: Pichtendahl (Nolcken), Aland (Reuter). Scandinavia: Sweden (De Geer). Switzerland: nr. Zürich (Frey).

NEPTICULA FLETCHERI, n. sp.

IMAGO.—Head blackish; eyecaps whitish-yellow; base of antennæ whitish. Anterior wings 4 mm.; bronzy, dark grey along the inner margin; apex strongly purple; cilia unicolorous dark grey. Posterior wings pale grey, rather darker towards apex; cilia dark grey.

---

* With regard to this, Richardson writes: "*N. anomalella* was recorded by mistake in *Lep. Dorset*, 1st Edition, p. 56, but omitted in 2nd Edition. One was bred August 20th, 1891, by E. R. Bankes. The larva, mine and cocoon cannot be separated from those of *N. centifoliella*, though the imago is quite different, and with this one exception, nothing but *N. centifoliella* has been bred from larvæ collected at Portland. Mr. Bankes, however, feels certain that no accidental mistake has occurred in the case of his specimen, which was bred with numerous *N. centifoliella* from wild rose, doubtless wild sweetbriar (*Rosa rubiginosa*), but possibly another kind growing near it. Probably *N. anomalella* occurs as elsewhere on cultivated roses" (*List of Portland Lepidoptera*, 1896, p. 190).

Egg.—The egg is placed by the side of the midrib beneath a leaf. It forms a perfect oval in outline, and is almost of the same shape and proportion (length, breadth, thickness) as a hen's egg, the shell transparent. slightly iridescent, and packed inside with a ring of black frass. Under a two-thirds lens the surface of the shell appears to be quite smooth.

Mine.—The mine in *Rosa arvensis* commences as a faint thread, so nearly of the same colour as the leaf as to be almost indistinguishable. In the first part of the mine the frass forms a pretty continuous thread along the centre of the mine, but after the mine is about half an inch long the larva moults, and the minute frass pellets are distributed over the whole width of the mine, which is in this portion particularly inconspicuous; this portion of the mine is possibly an inch in length. The larva evidently moults again, and immediately the gallery widens considerably; the frass is arranged in regular lines following the direction of the mine, and a broad whitish-green edge is left on either side of the frass-track. This portion of the track, including the windings, is at least two to two and a-half inches in length. The full-fed larva leaves the mine by the upper side of the leaf. [Described from mines sent by Mr. W. H. B. Fletcher, June 21st, 1898.]

Comparison of mines of N. fletcheri with N. anomalella.—We are indebted to Mr. Fletcher for mines of the "red-headed" form, in leaves of *Rosa sempervirens* var., for mines of the same form in leaves of *Rosa canina*, and for mines of the "black-headed" form in leaves of *Rosa arvensis*. We may say at once that the mines in *R. sempervirens* and *R. canina* are identical in every respect, long sweeping mines with broad curves, and with the frass exceedingly densely packed in the centre of the gallery throughout the whole length of the mine, the frass brownish at first, but afterwards black. The mine in the leaf of *Rosa arvensis* differs greatly, not only in the appearance of the pale (almost whitish) track itself, but in the inconspicuousness of the early part of the mine, in its sharply defined boundary against the parenchyma in the later portion; its more sudden widening in the middle part of its course, and in the enormous difference in the disposition of the frass. Instead of the dense black line which characterises the mines in *R. sempervirens* and *R. canina*, the mine in *R. arvensis* shows no trace of frass to the naked eye, only a rather darker green shade, where one knows the frass should be. Under a two-thirds lens the minute black frass pellets form a distinct central broken line; in the second part they are brownish and scattered over the whole width of the mine; in the third part the mine suddenly widens, and the pellets, although still scattered and separate, form a distinct central path, a character that is now maintained to the end, for, instead of the thick central black line of the mine of the "red-headed" form, the individual pellets are here scattered separately over the central part of the gallery, it being a rare occurrence for even two frass pellets to touch each other, and their regularity in lines following the direction of the gallery is sometimes remarkable.

Cocoon.—The cocoons examined average 2·2 mm. in length and 1·9 mm. in width. They vary much in shape, according to the position in which they have been spun up. Some, constructed in the narrow hollow of a contracted stipule at the base of the petiole, form a long oval 2·5 mm. long and only 1·4 mm. wide, whilst those spun up on the level surface of a piece of paper form an oval approaching the circular. They are all, however, decidedly smaller than the cocoons sent by Fletcher as those of the "red-headed" species (*anomalella*). The cocoon is dark brown in colour, paler on the bulging rim, which is somewhat thinned out before it gives rise to the dome-like arch, which is strongly developed, shiny, of a somewhat felted appearance, plentifully supplied with loose silken ends, which are, however, much more abundant on the outer rim. In those that are spun up in a narrow cranny the cocoon is of considerable depth; there is no paler rim, and the upper surface is very plentifully supplied with loose silken fibres. The empty pupa-case projects from the somewhat broader end beneath the rim, which here forms a sort of flange. The pupal skin is transparent, not so delicate-looking as that of some species, and rather grey in tint. [Described June 21st under a two-thirds lens, from cocoons sent by Mr. W. H. B. Fletcher.]

FOOD-PLANT. — *Rosa arvensis* (Fletcher). Corbett records it as abundant in *R. arvensis*, at Doncaster, the species in *R. canina* not occurring. Bankes states that he also breeds it from garden rose.

TIME OF APPEARANCE.—The insect is double-brooded, the imagines appearing in May and August, from larvæ that have fed up in October-November and July respectively.

LOCALITIES.—Probably widely distributed all over the British Islands. DORSET: Corfe Castle (Bankes). FLINT: Northop, nr. Mold (Bankes). HANTS: New Forest (Fletcher). LINCOLNSHIRE: Woods nr. Alford (Fletcher). SUSSEX: Slindon, Clapham, Porham, Balcombe (Fletcher). YORKSHIRE: Doncaster (Corbett).

NEPTICULA DESPERATELLA, Frey.*

SYNONOMY.—Species: *Desperatella*, Frey, "Die Tineen," etc., p. 374 (1856); "Linn. Ent.," xi., p. 384 (1857); Nolcken, "Lep. Fn. Estl.," p. 765 (1871); Staud. and Wocke, "Cat.," p. 336 (1871); Sand, "Cat. Lep. Auvergne," p. 200 (1879); Peyer., "Cat. Lep. Alsace," 2nd Ed., ii., p. 166 (1882); Sorhagen, "Die Kleinschmett. Brandbg.," p. 303 and p. 344 (1886); Wood, "Ent. Mo. Mag.," xxiii., pp. 188-189 (1887); Meyr., "Handbook," etc., p. 716 (1895).

ORIGINAL DESCRIPTION. — *N. desperatella*, n. sp. Capillis rufis, antennarum conchula albo-flavido; alis anter. cupreis, valde nitidis, apice saturate cupreo, ciliis fuscis 2½—2‴. Der vorigen Art (*minusculella*), ebenso den beiden folgenden Spezies (*anomalella* and *tiliae*) nahe verwandt; durch die lebhaft rothen Scheitelhaare aber von *N. minusculella* auf den ersten Blick zu unterscheiden. Eigenthümlich ist das stark glänzende Kupferbraun der etwas breiten Vorderflügel, welches in dieser Weise bei keiner anderen mir bekannten Spezies vorkommt. Gesicht und Schopf lebhaft ockerroth. Die mässig grossen Augendeckel sind weisslichgelb (bei manchen Stücken gelb). Die Fühlergeisel schwärzlich. Rückenschild kupferig, Hinterleib grauschwarz; Beine ebenso, nur die Fussspitze des letzten Paares etwas lichter. Die Vorderflügel haben, ungewöhnlicher Weise stark glänzend, eine lebhafte Kupferfarbe (viel mehr gegen das Röthliche ziehend als bei *N. minusculella*). Gegen die Spitze werden sie dunkler, aber ohne jeden violetten Anflug. Die Franzen dunkel braun. Hinterflügel und ihre Franzen dunkler grau als bei voriger Art (Frey, *Die Tineen und Pterophoren der Schweiz*, etc., p. 374).

---

* In the *Correspondenzblatt*, 1860, p. 59, Herrich-Schäffer writes: "*N. incognitella*, später von Frey als *desperatella* beschreiben."

Imago.—Head reddish. The anterior wings 4·5 mm.; unicolorous bronzy; the apex deep coppery; cilia fuscous. The hindwings and cilia dark grey.

Egg-laying.—The eggs are laid on the underside of a leaf (Nolcken).

Mine.—The mine is at first a slender line, running usually along the edge of a leaf, for some distance; it then widens into a broad, twisting gallery, in which the windings coalesce, and form a sort of false blotch. The larva prefers tiny leaves on small inconspicuous shoots growing close to the ground (Wood). Frey's description of the mine reads as follows: "Die Mine beginnt als ein sehr dünner, stark geschlängelter Gang mit feiner, die Ränder nicht erreichender Kothlinie. Er verbreitert sich allmälig, immer starke Windungen machend, um zuletzt einen ziemlichen Querdurchmesser anzunehmen. Auch hier bleibt die Kothmasse ein sehr feiner Streifen, so dass der grössere Theil des Ganges leer und bräunlich erscheint. Die Mine ist am meisten an diejenige von *N. tiliae* erinnernd, und leicht von dem kürzeren, mit breiterer Kothreihe versehenen Gange der *N. minusculella* zu unterscheiden" (*Die Tineen*, etc., p. 374). Nolcken writes: "Die Mine, oft zahlreich in einem Blatte, ist in ihrem ersten längeren Theil fein, wenig gewunden, mit helleren und dunkleren Stellen (da anfänglich nicht alles Chlorophyll vollständig weggefressen wird) und lang gedehnt, dann wächst sie rasch in die Breite und die Windungen liegen ohne Zwischenwände so dicht an einander, dass eine grosse Makel entsteht, in welcher aber der Kothstreif den Gang der Windungen zeigt. Dieser, am unterseitigen Ei als feine Linie mit etwa gleich breiten hellen Rändern beginnend, erscheint von der Stelle an, wo die Mine sich rascher erweitert, mehr körniger, in wechselnder Breite mit zerrissenen Rändern, öfter in einzelne Körnchen, Häufchen und Streifen zerfallend; immer aber bleibt er schmal im Verhältniss zur Minenbreite und ist von einem verschwommenen bräunlich rothen Scheine beiderseits breit eingefasst, welcher Schein sich öfter auch über die Grenze der Mine auf die benachbarten Blatttheile in verschiedener Ausdehnung verbreitet. Ausgangsklappe oberseitig. Diese Minen finden sich immer nur an einzelnen Bäumchen jedesmal zahlreich, während sie vielen anderen in nächster Nähe fehlen."

Larva.—Frey writes: "Die Larve ist ziemlich lebhaft grün colorirt und hat etwa 2‴ Körperlänge. Ihr Kopf ist nicht dunkler als der Leib." Wood writes: "The larva lies in the mine with the back up. The colour is bluish-green, or almost greenish-blue. The alimentary canal red. The head very pale grey, with the mouth-parts red. The cephalic ganglia and nerve chain invisible. A pair of amber-coloured markings sometimes visible on the back of the 1st thoracic segment" (*in litt.*, May 16th, 1898). Nolcken says that the larvæ "waren vorn lebhaft grün mit dunkler grünem Darm, der in der Endhälfte in röthlich Braun übergeht, welches sich auch dem ganzen Leibe, aber heller und verwaschen, mittheilt, so dass nur dessen Seiten grün bleiben; der kleine Kopf ist fast wasserhell bräunlich mit dunkleren Nähten und Gebiss."

Cocoon.—The cocoons (4) average 2·1 mm. in length, and 1·7 mm. in width. The cocoon varies slightly in shape, from an almost complete oval to an oblong oval; there is a considerable lateral flange, from which rises a regular dome-shaped structure, which reaches its greatest height towards what is the slightly broader end of the cocoon. The cocoon proper is comparatively smooth, of a bright orange-red colour, which is quite brilliantly orange in some parts, and in some lights. The surface of the cocoon is finely reticulated with dark red. The cocoon proper is invested in a loose, flossy coating of orange coloured silk, which, along the flange, forms what can best be described as a belt of gold. The inside of the cocoon appears to be smooth and exceedingly shiny. [Described June 16th, 1898, under a two-thirds lens, from cocoons sent by Dr. Wood.] The empty pupa-case is left projecting from what is, perhaps, the rather broader end of the cocoon. It is quite transparent, exceedingly thin, with a faint grey-green tint, and a few greyish markings on the thoracic segments. Frey writes: "Der Cocon ist länglich rund, glatt, ziemlich abgeplattet und von einer lebhaft braunrothen Farbe." Nolcken says: "Die flach eiförmigen, sehr dunkelbraunen Cocons waren theils an den Sand des Behälters, theils an Blätter angesponnen."

Food-plant.—Wild apple (*Pyrus malus*). The larva is generally found on the smallest (and youngest) wild apple bushes, often in prodigious numbers; all the leaves appearing brown from the mines of these larvæ, of which Frey has found more than a dozen in one leaf. He adds, that though he bred the insect freely he never saw a single imago at large.

Time of appearance.—The species is single-brooded, the larvæ appearing from the end of August to the beginning of October, and producing moths during the first fortnight of June. Nolcken found larvæ on October 3rd, 1865, and August 26th, 1866, at Pichtendahl.

Localities.—Hereford: Tarrington, local, apparently confined to one wood, and refusing to attack the wild apple in adjoining hedges (Wood). Lancashire: Grange (Threlfall). Norfolk: King's Lynn, extremely local (Atmore). Westmorland: Windermere (Hodgkinson).

Distribution.—France: Nohaut (Sand). Germany: Alsace (Peyerimhoff), Breslau, Hanover, ? Hamburg (Sorhagen). Russia: Pichtendahl (Nolcken). Switzerland: near Zürich (Frey).

NEPTICULA TILIÆ, Frey.

Synonymy.—Species: *Tiliae*, Frey, "Die Tineen," etc., p. 375 (1856); "Linn. Ent.," xi., p. 381 (1857); Sta., "Ent. Ann.," 1860, p. 136; "Nat. Hist. Tin.," vii., p. 168, pl. viii., fig. 2 (1862); Staud. and Wocke, "Cat.," p. 335 (1871); Hein., "Wien. Monats.," vii., pp. 241 and 246 (1862); Hein. and Wocke, "Schmett. Deutsch.," p. 734 (1877); Sand, "Cat. Lep. Auv.," p. 200 (1879); Peyer., "Cat. Lep. Als.," 2nd Ed., p. 165 (1882); Sorhagen, "Die Kleinschmett. Brandenburg," p. 303 (1886); Meyrick, "Handbook," etc., p. 715 (1895).

Original description.—*N. tiliae*, n. sp. Capillis atris, antennarum conchula (♂ magna) flavido-alba; alis anter. saturate fusco-æneis, apice violaceo-purpureo, ciliis fusco-griseis 2½-2‴. Der vorigen Art, namentlich dunklen, schwarzköpfigen Exemplaren der *N. anomalella*, so nahe verwandt, dass wohl nur durch die Erziehung völlige Sicherheit zu gewinnen ist. Als Merkmale gelten die beim Männchen sehr ansehnlichen, heller gelblichweissen Augendeckel, welche grösser sind als bei *N. anomalella*, so dass dadurch der schwarze Schopf schmäler erscheint, während die des weiblichen Thieres beider Arten sich gleich verhalten; ferner die etwas dunklere Bronzefarbe der Vorderflügel, an welchen ich bei meinen sieben Stücken keine Aufhellung nach der Mitte hin zu bemerken vermag. Das beste Merkmal bildet aber die

Flügelspitze, welche bei unserer Spezies niemals rein violett, sondern vielmehr purpurglänzend erscheint; bisweilen fast rein purpurfarben. Die Franzen grau, wie bei vorhergehender Spezies" (Frey, *Die Tineen und Pterophoren der Schweiz*, pp. 375-376).

Imago.—Head black. Anterior wings 4-5 mm. in expanse; dull bronzy in colour, with the apex of a rather dull purple hue, which shades gradually into the greyish-purple cilia. Posterior wings and cilia pale grey.

Comparison of N. tiliæ with its allies.—*N. tiliae* belongs to the unicolorous section of the genus, and from its black head, can only be confounded with *N. atricapitella*, *N. minusculella*, *N. lonicerarum*, and the black-headed specimens of *N. anomalella*. From *N. atricapitella* it may be most easily separated by its much smaller size, and by the less glossy anterior wings. From *N. minusculella* it may be distinguished by the anterior wings being broader and of a duller colour. *N. tiliae* very closely resembles *N. lonicerarum*, but the anterior wings are scarcely so dull as in the last-named species. From *N. anomalella*, *N. tiliae* is best distinguished by the purple apex of the anterior wings shading gradually paler into the cilia; in *N. anomalella* the purple apex is quite sharply defined against the grey cilia. Besides, *N. anomalella* has the wings more glossy, and generally with a faint indication of a pale fascia beyond the middle (Stainton).

Egg-laying.—The egg is laid on the undersurface of a leaf of the lime tree, against a rib.

Mine.—The mine is contorted and slender, and does not occupy at its commencement the whole thickness of the parenchyma; the excrement forms a slender, blackish line for a considerable distance, and sometimes for the whole length of the mine, but not infrequently, in the second half of the mine, it occupies nearly the whole width of it, being deposited in a series of curves (much as in the mines of *N. viscerella*). Sometimes the mine is entirely of the latter form, and then it is generally much contorted. In some mines the excrement retains its linear form throughout, so that one would almost feel inclined to assume that we had here two distinct species, but some mines are decidedly half of one form and half of the other (Stainton). Previously these two forms of mine had been noticed as probably belonging to two different species of *Nepticula* (*Ent. Ann.*, 1859, p. 163). Hodgkinson reports as many as eight larvæ in a single leaf, near Stoneyhurst. Frey writes: "Die Mine hat ein ganz eigenthümliches Ansehen. Sie ist sehr stark gekrümmt, indem die Windungen unregelmässig und ganz dicht an einander gedrängt verlaufen. Der Anfang derselben ist sehr fein und von der zarten braunen Kothlinie ganz erfüllt. Weiter abwärts wird der Gang breiter und, indem die Kothlinie einfach bleibt, erscheinen die Ränder jenes leer und weiss. Erst gegen das untere Ende liegen die Kothmassen wie bei *N. anomalella*. Es kommen zuweilen 3-4 Gänge in einem grösseren Blatte vor" (*Linn. Ent.*, xi., p. 382).

Larva.—Length 2 lines. Pale amber-yellow, with the dorsal vessel rather dark green; head pale brown, with two dark brown lobes showing through the skin of the second segment (Stainton). Frey writes: "Die blasser gelbe, gegen 2‴ grosse Raupe minirt im September und Anfang Oktober die Blätter von Lindenbüschen (*Tilia grandiflora*) in unseren Gebirgswäldern; namentlich an etwas beschatteten Stellen" (*Die Tineen*, etc., p. 376). It mines with the dorsum uppermost.

Cocoon.—The cocoons (4) examined average 2 mm. in length and 1·75 mm. in width, and are spun on the under surface of the leaves of their food-plant. The cocoon is roughly oval in outline, but with one end (from which the empty pupa-case projects) much wider than the other. The broad end is considerably flattened in some of the examples, less so in others, the domed portion rising up very considerably centrally, and forming somewhat of a point at the apex. The cocoon is somewhat roughened and wrinkled, and a number of fine silken ends, of the same pale yellowish colour as the cocoon itself, project from all over its surface. The marginal rim is somewhat crenate, and there are here more loose silken fibres than elsewhere, this being the portion of the cocoon which is directly attached to the outlying ribs, although considerably above the surface of the leaf. The projecting pupa-case is absolutely colourless, transparent, and very delicate, the surface finely pitted, and beautifully iridescent. [Described June 28th, 1898, under a two-thirds lens, from cocoons sent by Mr. W. H. B. Fletcher.] Wood notes the cocoon as pale ochreous-yellow in colour. Ten cocoons sent by this observer averaged 2·2 mm. in length, and 1·6 mm. in width, and showed considerable minor variation in shape, although they were more distinctly equal at the ends than the cocoons previously described. They are of a bright yellow-ochreous colour, somewhat brighter in hue than those sent by Fletcher, a number of rather darker reticulations extending over the surface of the well-developed dome. Frey describes the cocoon as "stark abgeflacht, unregelmässig länglich rund, von hellem Colorit, hellgelb oder ockerfarben."

Food-plant.—*Tilia grandiflora* (Frey), but *Tilia parvifolia* is probably its food-plant in Britain.

Time of appearance.—The species appears to be single-brooded, the imagines appearing in May and June from larvæ collected the previous September-October. Vaughan found mines near Bristol, September 14th, 1859. Frey bred imagines in March in his room, from mines found the previous September.

Localities.—Gloucestershire: Bristol, Leigh Woods (Vaughan). Hereford: Dowards, Woolhope (Wood). Lancashire: Grange, Preston, between Ashton and Stoneyhurst (Hodgkinson). Westmorland: Arnside (Hodgkinson).

Distribution.—France: Nohaut, Indre (Sand). Germany: generally distributed (Heinemann and Wocke), Ratisbon (Stainton), Frankfort-on-the-Main (Frey), Friedland, Stettin (Sorhagen), Faisanderie, nr. Saverne in Alsace (Peyerimhoff). ? Russia: Pichtendahl (Nolcken). Switzerland: Zürich (Frey).

NEPTICULA BASIGUTTELLA, Heinemann.

Synonymy.—Species: *Basiguttella*, Hein., "Wien. Monats.," 1862, p. 258; Hein. and Sta., "Zool.," 1863, p. 8358; Staud. and Wocke, "Cat.," etc., p. 335 (1871); Nolcken, "Lep. Fn. Est.," p. 756 (1871); Hein. and Wocke, "Schmett. Deutsch.," p. 732 (1877); Sand, "Cat. Lep. Auv.," p. 206 (1879); Peyer., "Cat. Lep. Als.," ii., 2nd Ed., p. 164 (1882).; Sorhagen, "Die Kleinschmett. Brandenburg," p. 344 (1886); Meyr., "Handbook," etc., p. 715 (1895).

Original description.—6. *N. basiguttella*. Capillis atris, pencillis et antennarum conchula albidis, thorace atro; alis anterioribus subnitidis, violaceo-æneis, basi flavidis, apice violaceo-purpureis, ciliis

fusco-griseis, $2\frac{1}{6}$–$2\frac{1}{3}'''$. Diese Art ist der *N. tiliae* sehr ähnlich, aber grösser und plumper, und unterscheidet sich von ihr und den übrigen schwarzköpfigen Nepticulen ohne Binde durch den lichten Basalfleck der Vorderflügel und den schwarzen Thorax, von den meisten derselben auch durch das rostgelbe Untergesicht und durch die viel hellere silbergraue Farbe der Beine und des Bauches. Der Scheitelzopf ist schwarz, das Untergesicht rostgelb behaart oder doch von einer rostgelben Linie der Länge nach getheilt; die Augendeckel sind in beiden Geschlechtern gross und wie die Nackenschöpfe und Taster weiss oder gelblichweiss, die Fühler glänzend silbergrau, dicht dunkel geringelt, bei dem Manne bis $\frac{2}{3}$ des Vorderrandes der Vorderflügel reichenden Thorax mit den Schulterdecken ist bis auf die lichtere Stelle des Schildchens tief schwarz, was besonders bei den noch nicht aufgespiessten Thierchen auffält, der Hinterleib schwärzlich grau, bei dem ♂ mit rostgelber Spitze, die Hinterseite des Körpers und die Beine sind licht silbergrau, letztere aussen etwas dunkler. Die Vorderflügel haben im Grunde eine sehr lichte, fast weissliche, glänzende Erzfarbe, die aber durch die mehr oder weniger breit bräunlich violetten Spitzen der Schuppen verdunkelt und getrübt ist. Die reinste und lichteste Stelle ist die Basis, an welcher die lichte Grundfarbe ein kleines, nicht scharf begrenztes gelblich weisses Fleckchen bildet; gleich dahinten sind die Schuppen am gleichmässigsten verdunkelt in der Flügelmitte werden sie allmälig wieder lichter, besonders am Innenrande, wo wieder eine unbestimmte von dunklen Schuppen freie helle Stelle vor dem Innenwinkel sich findet, die bisweilen fast bindenartig bis zum Vorderrande sich erstreckt. Die Spitze des Flügels ist dunkel violettblau. Die Fläche des Flügels ist glänzend und ziemlich glatt, doch nicht so geglättet wie bei *N. tiliae.* Uebrigens variiren die Vorderflügel nicht unerheblich, je nachdem die lichte Grundfarbe oder die dunklen Schuppen vorherrschen, immer ist aber der helle Fleck an der Wurzel deutlich und sticht gegen die dunkle Stelle dahinten, sowie gegen den schwarzen Thorax lebhaft ab. Die Wurzel der Fransen ist bis an den Innenwinkel wie die Flügelspitze dunkel violettblau, ihre Spitze dunkelgrau, am Innenwinkel und Innenrande sind die ganzen Fransen lichtgrau, eine Theilungslinie ist nicht vorhanden. Die Hinterflügel ohne Auszeichnung, hellgrau mit wenig dunkleren Fransen (Heinemann, *Wien. Ent. Monats.*, vi., 1862, pp. 258-259).

Imago.—Head black above, face dull yellowish. Anterior wings 5-6 mm.; pale (almost whitish) shining bronze, with a purplish tinge; basal spot and anal angle paler; apex dark purplish; cilia dark purplish with dark grey tips, at the anal angle and inner margin the cilia pale grey. The posterior wings pale grey, cilia a trifle darker.

Variation.—The fore-wings vary not inconsiderably, according as the light ground-colour or the dark scales predominate, but the pale spot at the base is always distinct, and strongly contrasts with the dark parts beyond, as also with the black thorax (Heinemann).

Comparison of N. basiguttella with N. tiliæ.—*N. basiguttella* is very like *N. tiliae*, but larger and stouter. It is distinguished from that and from the other black-headed Nepticulids that have no fasciæ by the pale basal spot of the anterior wings and the black thorax; from most of them also by the rusty yellow lower part of the face, and by the much paler silvery-grey colour of the legs and belly. The

disc of the wing is strong and rather smooth, but not so glossy as in *N. tiliae* (Heinemann).

Egg-laying.—The egg is always laid on the upperside of an oak-leaf, by the side of a large vein, or in the angle between two veins. Nolcken says he has never found an egg on the surface of the leaf away from a rib. He further writes: "The egg is not pushed under the epidermis, but glued upon the outside of the leaf. It forms an elliptical, more or less pearly, shining pustula, thickly covered with a white shiny gum, by which it is fastened to the leaf."

Mine.—The mine is almost of the colour of the oak leaf in which it is placed, and hence is difficult of detection. In the mine the frass is coiled, the pellets being arranged in superimposed, slightly curved, rows, which run across the mine with the nicest precision. Heinemann writes: "The mine forms a long, rather tortuous gallery of nearly uniform width, entirely filled up with dark green excrement." Nolcken describes the mine as being "very long, gradually increasing in width, with many convolutions, and extending over a large part of a leaf, the flap from which the larvæ finally escapes being on the upperside, and resembling a horse-shoe in shape. The mine cannot be seen from the underside of the leaf, and in its early stages is with difficulty detected on the upperside, since the excrement is then greenish, and only becomes blacker later in the insect's life. In dried leaves, the commencement of the mine, seen from above, appears to be of a pale, dirty, yellowish-green colour, without a distinct frass-line. This latter becomes suddenly visible, probably after a moult. Held against the light, the whole of the mine appears, from its commencement onwards, to be entirely filled up with green, and later, with darker green (almost blackish-green) frass, so that only a very narrow, pale margin exists on either side of the frass-line, until towards the end of the mine, when the margins become broader and more distinct. In the first part of the mine the frass-line exists as a somewhat interrupted, fine, uniformly coloured dark thread. It then presents the appearance of lighter and darker spots, usually with the darker frass lying along the margins. Owing to the movement of the larva in its gallery whilst eating, the frass is deposited transversely, sometimes irregularly, but at others forming a series of zigzag lines, where the frass is deposited in a series of short curves. It would appear as though the climatic conditions (whether wet or dry at the time of its formation) influence the character of the frass-line."

Comparison of the mine and larva of N. basiguttella with those of the allied species.—The mines of *N. samiatella*, *N. ruficapitella* and *N. atricapitella* differ in the following characters from that of *N. basiguttella*. Their mines are broader, the frass-line usually runs as a narrow, strikingly blackish thread along their middle, leaving very wide, conspicuous, whitish margins on either side, the margins being double the width of the thread. In many mines (often only in places) the frass-line becomes granular, consisting of scattered pellets, and broader than usual, but even then paler areas and the light margins remain, and are much broader than in the mine of *N. basiguttella*, whilst the whole of the leaf cuticle affected by the mine is more strikingly coloured, whitish or brownish. In addition, *N. basiguttella* has a green larva, whilst those of the other named species are yellow, with a reddish-brown intestinal canal. *N. subbimaculella* (according to Stainton), which also has a greenish larva, appears very late, forms at first a slender mine, with a thick frass-line, but is soon changed to a somewhat long blotch, in which the excrement lies about in a rather scattered and irregular manner (Nolcken).

Larva.—The larva is green, and may be found in oak-leaves in July, and again in September and October (Heinemann).

Cocoon.—The cocoons average 2·1 mm. long, and 1·75 mm. wide. They are of a bright reddish-brown (almost orange-brown) colour, almost oval in outline, one end being rather narrowed. There is a distinct outer rim projecting all round the edge, whilst the central portion is considerably raised. The cocoon proper forms a closely woven structure, with a moderately smooth surface; investing this there is a very slight loose web of white flossy silk. The superficial resemblance (except for its smoothness) to a peach-stone is marked. [Described under a two-thirds lens on June 14th, 1898, from cocoons sent by Dr. Wood.]

Food-plants.—*Quercus robur* and *Q. pedunculata*.

Time of appearance.—Bred June 7th-16th, 1879, from mines collected at Madingley and Sandy, in November, 1878, the latter date being late, and many mines untenanted (Warren). The same observer bred many specimens between May 23rd and 29th, 1882. Stainton found larvæ abundant on September 26th, 1865, at Wilhelmsbad, and Nolcken, from August until the commencement of October, at Pichtendahl. Sorhagen reports it as double-brooded in Silesia, the imagines appearing in May and late July, from larvæ that feed up in October and early July respectively.

Localities.—Beds: Sandy (Warren). Cambridge: Madingley (Warren), Cambridge (Farren). Hereford: Tarrington (Wood). Kent: West Wickham Wood (Sang). Lincolnshire: nr. Alford (Fletcher). Suffolk: Tuddenham (Warren).

Distribution.—France: Mont Doré (Sand). Germany: northern and western Germany (Wocke), Brunswick, Hanover and Silesia (Heinemann), Wilhelmsbad, nr. Frankfort-on-the-Main (Stainton), Hamburg (Sorhagen), Alt Damm, Friedland, etc. (Hering), Alsace (Peyerimhoff). Russia: Pichtendahl (Nolcken). Switzerland: Zürich (Frey).

NEPTICULA NYLANDRIELLA, Tengström.

Synonymy.—Species: *Nylandriella*, Tengstr., "Bidrag," etc., p. 152 (1847); H.-Sch., "Sys. Bearb.," v., p. 359 (1855), fig. 927 (1854); Frey, "Linn. Ent.," xi., p. 445 (1857); Hein., "Wien. Monats.," 1862, p. 259; Hein. and Sta., "Zool.," 1863, p. 8359; Staud. and Wocke, "Cat.," p. 336 (1871); Wallengren, "Bihang Vet.-Ak. Handl.," iii., p. 80 (1875); "Ent. Tids.," ii., p. 126 (1881); Sorhagen, "Die Kleinschmett. Brandbg.," p. 344 (1886); Griffith, "Ent. Mo. Mag.," xxii., p. 65 (1885); Warren, "Ibid.," p. 131 (1885): Meyrick, "Handbook," etc., 716 (1895).

Original description.—*Nepticula nylandriella*, Zell. (*in litt.*). Minima tota æneo-cinerea nitida, capillis lutescentibus. Long. alæ ant. vix 1¾ mm. Simillima præcedenti (*concolorella*), at duplo minor. Allmän vid Helsingfors i början af Juni pa Hägg och Björk. (Tengström, *Bidrag till Finlands Fjaril-Fauna*, p. 152).

Notes on original description, etc.—Frey remarks that the figure in H.-Schäffer represents an insect entirely leaden-coloured, with ochreous-yellow head, and asks: "May it not be a much wasted specimen?" Warren, commenting on the above, writes (*E.M.M.*, xxii., p. 132), that the preceding species referred to by Tengström is

Bucculatrix concolorella, treated as a distinct species by Staudinger and Wocke (*Cat.*, p. 334, no. 2956), but which he (Warren) considers identical with *B. cristatella*, Zell. He adds that the resemblance that *N. nylandriella* bears to very small *B. cristatella* is very striking, and that Herrich-Schäffer's figure represents the species admirably. There is not a trace of purple towards the apex, and the insects he has examined are certainly not wasted.

Imago.—Head yellowish, frontal tuft of ♂ brown, of ♀ pale ochreous. Anterior wings narrow, very smooth, extremely shiny, pale silvery-grey, with a faint yellowish tinge; apex scarcely darker, with a faint violet gloss; cilia whitish-grey, rather darker towards their base. Posterior wings and cilia pale grey.

Sexual dimorphism.—The frontal tuft of the male is brown, that of the female pale ochreous-yellow. The cervical tuft of the male is more whitish, that of the female pale yellow.

Mine.—Gangmine geschlangelt (Sorhagen).

Food-plant.—*Pyrus aucuparia* (Wocke).

Time of appearance.—The original specimens on which the species was named were captured near Helsingfors, in June. Imagines were captured by Griffith, on June 6th, 1885, on the trunks of mountain-ash trees, in a wood on Betty Hill, in Sutherland. Sorhagen gives the larvæ as occurring in August-October, the imagines in May and June.

Localities.—Lancashire: Preston (Threlfall). Sutherland: Betty Hill (Griffith).

Distribution.—Germany: Hanover, Breslau (Sorhagen), Brunswick, on beech trunks (Heinemann). Russia: Helsingfors (Tengström). Sweden: (Wocke).

Group II.—Cilia of the anterior wings with no dark divisional line, but cilia becoming gradually paler towards their tips. Anterior wings with a pale metallic transverse fascia; basal area smooth and metallic, fascia with a more or less defined margin towards base.

NEPTICULA REGIELLA, Herrich-Schäffer.

Synonymy.—Species: *Regiella*, H.-Sch., "Sys. Bearb.," v., p. 351 (1855); Frey., "Die Tineen," etc., p. 391 (1856); "Linn. Ent.," xi., p. 434 (1857); Sta., "Ent. Ann.," 1857, p. 111; "Man.," ii., p. 437 (1859); "Nat. His. Tin," vii., p. 150 (1862); Staud. and Wocke, "Cat.," p. 336 (1871); Nolcken, "Lep. Faun. Est.," p. 766 (1871); Sand, "Cat. Lep. Auv.," p. 200 (1879); Peyer., "Cat. Lep. Als.," 2nd Ed., ii., p. 166 (1882); Sorhagen, "Die Kleinschmett. Brandenbg.," p. 308 (1886): Hering, "Stett. Ent. Zeit.," lii., p. 220 (1891); Meyr., "Handbook," etc., p. 716 (1895).

Original description.—*Regiella*, Frey.—Magnit. 3; alis ant. aeneoviolaceis, fascia pone medium lata, suborbiculari, limbum versus aureo-cincta, alis p. nigris. Flügel deutlich breiter als bei *marginicolella*, die hintern dunkler blauschwarz, die vorderen kupferbronze, ohne Violett, das Silberband stärker gelblich, wurzelwärts unbestimmt begrenzt, in gewisser Richtung einen runden Fleck vorstellend, also am Vorder- und Innenrand schmaler, saumwärts fein golden begrenzt; die Endhälfte der Franzen deutlich lichter grau Keine lichten Nackenschöpfe. Augendeckel klein. Von Weissdorn (Herrich-Schäffer, *Sys. Bear. der Schmett. von Europa*, v., p. 351).

Imago.—Head reddish-yellow. Anterior wings 4-5 mm.; pale golden-brown tinged with purple; a broad dull golden fascia beyond the middle; immediately beyond the fascia are some coppery scales in the deep purple portion of the wing; cilia greyish, whitish at the tips. Posterior wings grey, with paler cilia. [This species may be distinguished from all its near allies by the indistinctly marginal brassy fascia on the pale golden-brown anterior wings (Stainton).]

Egg-laying.—The eggs are laid immediately under the edge of the lobes of a hawthorn leaf (Wood). Nolcken notes the egg as being probably laid on both the upper- and under-side of a leaf, so that there is perhaps some variation in this respect.

Mine.—The mine runs at first along the margin of the leaf, ensuring by this means the subsequent advance of the blotch inwards, *i.e.*, from the margin towards the centre. Its gallery is short and coarse, but it scarcely ever reaches to any great distance from the edge of the leaf. The gallery terminates in a blotch, the frass being brown in the gallery and black in the blotch (Wood). Frey writes: "Ein prachtvolles Insekt, dessen Larve in ähnlicher, wohl nur kleinerer Mine als *N. gratiosella* an *Crataegus oxyacantha* lebt und gleich dieser Art gelb gefärbt ist" (*Die Tineen*, etc., p. 392). Nolcken says: "The mine commences with several fine convolutions, placed closely together, then for a distance the curves are extended and spread quite apart from each other. The mine then becomes broad somewhat abruptly, and remains so for the remainder of its length (about one-third of the total distance). Up to this point the mine is completely filled with frass, somewhat variable in its arrangement, but forming generally a pale or dark-brown band; the frass is rarely granulated, although it exhibits, in some places, a tendency in this direction. Until now the gallery has shown no paler margins, but in the much broader final third, which has somewhat irregular boundaries, unless margined by a leaf-vein, narrow pale margins appear, and soon become very broad, owing to the frass remaining as a narrow central stripe, no wider than in the early part of the mine, in some cases even not being continuous; the frass, too, becomes more granulated. The larva escapes from the upper side of the leaf."

Larva.—The larva is of a yellow ground-colour. Its head is pale brown, with the cephalic ganglia dark brown, and, consequently far more conspicuous than the head; a pair of brilliant orange spots are frequently present on the front edge of the pro-thorax (Wood). Nolcken writes: "The larva is yellow, the head very pale brown, the mouth-parts and sutures darker; the intestinal canal yellow, tinged with faint reddish."

Comparison of the mine and larva of N. regiella with those of N. ignobilella.—The larvæ of these species occur together at about the same time, and are double-brooded. The small blotches they make at the tips of the lobes, with their yellow or yellowish larvæ, are certainly provokingly similar, unless attention be paid to one or more of the following points, when their discrimination becomes easy: (1) Both species lay the egg on the underside of a leaf, that of *N. regiella* is laid quite on the edge, that of *N. ignobilella* well away from it. As a consequence, the whole course of the primary galleries of the former runs along the edge, whereas the gallery of the latter wanders at first about the area of the lobe, before it reaches and follows the edge, and though this wandering portion is afterwards absorbed by the blotch, the fine frass-track remains undisturbed, and an evidence of its former existence. (2) *N. regiella* deposits brown frass in its gallery, and black in the blotch, whereas the dejecta of *N. ignobilella* are black in both gallery and blotch. (3) The head of the larva of *N. regiella* is pale brown, with the cephalic ganglia dark brown, and far more conspicuous than the head; on the other hand, the head of the larva of *N. ignobilella* is blackish, overpowering the ganglia, which are of a paler colour (Wood).

Cocoon.—The cocoons examined (6) average 2·2 mm. in length and 1·6 mm. in width. In outline, the cocoon is ovate, the upper surface rising gradually from the edges to form a well-marked dome, the apex of which is rather nearer the broader end, and slightly flattened. The cocoon is of a red-brown tint, bright, and approaching plum colour. What appears to the naked eye to be a broad lateral flange, is a surrounding belt of yellow ochreous flossy silk, similar scattered threads being seen over the remainder of the surface. In some, this forms a coating sufficiently dense to hide the bright red-brown cocoon beneath, and one would surmise that, when freshly spun, the cocoon is surrounded by this loose silken covering. The older cocoons fade considerably, and to a great extent lose the bright red colour of the newer ones. [Described, June 16th, 1898, from cocoons sent by Dr. Wood.] The cocoon is spun on the surface of the ground.

Food-plant.—*Crataegus oxyacantha.*

Time of appearance.—The species is double-brooded (Wood). Stainton found imagines on June 23rd, 1852, on Dartford Heath fence, and it was bred by Edleston in June, 1856, from mines collected in September, 1855. Walsingham records imagines at Darenth Wood, May 9th, 1868. Frey records imagines, *in copulâ*, found nr. Zürich on August 13th, 1855. Sang collected mines on October 2nd, 1878, at Darlington. Nolcken found larvæ on September 8th and the following days, at Pichtendahl.

Localities.—Cheshire: Bowdon (Edleston). Dorset: Bloxworth (Cambridge). Durham: Darlington (Sang). Hereford: Tarrington (Wood). Kent: Dartford Heath (Stainton), Darenth Wood (Walsingham). Lancashire: Manchester (Edleston), Preston (Hodgkinson). Sussex: Arundel Park (Fletcher). Yorks: Scarborough (Wilson), York (Porritt, *List*).

Distribution.—France: Nohaut, Indre (Sand). Germany: Friedland, Brunswick, Hanover, Silesia (Sorhagen), Alsace (Peyerimhoff), Alt Damm (Hering). Russia: Pichtendahl (Nolcken). Switzerland: Zürich (Frey).

NEPTICULA TORMINALIS, Wood.

Synonymy.—Species: *Torminalis*, Wood, "Ent. Mo. Mag.," xxvi., pp. 209-210 (1890); Meyrick, "Handbook," etc., p. 716 (1895).

Original description.—Al. exp. 2¼ lin. Inner half of forewing pale golden-brown, followed by a broad, straight, brassy fascia, ill-defined on its inner edge; apex of wing purple. Head black, with white eye-caps. Antennæ half as long as fore-wings, just reaching, when the insect is at rest, to the commencement of the fasciæ (Wood, *Ent. Monthly Magazine*, xxvi., p. 209).

Imago.—Head black. Anterior wings 5-6 mm.; golden-brown from base to fascia; latter broad, straight and brassy; apex of wing purple; cilia fuscous. Posterior wings concolorous, fuscous.

Comparison of N. torminalis with N. regiella.—*N. torminalis* is very like *N. regiella*, so much so, indeed, that it has been necessary to use almost the very terms in which the latter has been described in the

Manual. It is, however, a trifle larger, and the tone of the colouring is not quite so deep; but the character that serves at once to distinguish it is the black head, that of *N. regiella* being red. The larva, mine, and food-plant are also quite different, and it is, besides, a single-brooded species, the mines occurring in July (Wood).

Egg-laying.—The egg is laid on the under-side of a leaf of *Pyrus torminalis*, in an interspace between the ribs.

Mine.—The mine begins as a fine, straight gallery, then becomes wide and twisting, almost widening into a blotch before its termination; the frass collected into a narrow central line.

Larva.—Pale yellowish. Head blackish, sockets in which the posterior lobes work, black, appearing as a pair of black spots behind the head; a row of linear brown marks down the middle of the ventral surface, not noticeable when in the mine.

Cocoon.—The cocoon is spun on the surface of dead leaves, etc., lying on the ground. The shape of the cocoon reminds one of an almond, and the resemblance is somewhat increased, when the cocoon is examined under a two-thirds lens, by the loose, flossy, silken covering by which the cocoon proper is surrounded. The end of the cocoon from which the pupa emerges is much broader than its nadir. In colour it is of a rather bright orange-brown tint, with a considerable range of variation, some being more inclined to brown, others to orange. The main structure is fairly closely woven, and moderately smooth, but with a loose, flossy, silken outer covering enveloping it. This loose silk is particularly abundant on the upper surface, where it sometimes forms a conspicuous bunch. The empty pupa-case projects from the cocoon to about the 4th or 5th abdominal segment. [Described June 9th, under a two-thirds lens, from cocoons sent by Dr. Wood.]

Pupa.—The chitin of the pupa-case is exceedingly delicate and fragile, transparent, slightly amber in tint, but colourless on the raised portions of the appendages and segments.

Food-plant.—*Pyrus torminalis.*

Time of appearance.—The species is single-brooded, the imagines appearing in May and the beginning of June, from larvæ collected the previous July.

Localities.—Hereford: Tarrington, confined to a small corner of one wood, where it is fairly common, nearly every bush of its food-plant having a few tenanted leaves, with occasionally two or even three mines in a leaf (Wood).

NEPTICULA ÆNEOFASCIELLA, Herrich-Schäffer.

Synonymy.—Species: *Aeneofasciella*, H.-Sch., "Sys. Bearb.," v., p. 353 (1855); Hein., "Wien Ent. Monats.," 1862, p. 262; Nolcken, "Lep. Fn. Est.," p. 767 (1871); Staud. and Wocke, "Cat.," p. 336 (1871); Sand, "Cat. Lep. Auv.," p. 200 (1879); Peyer., "Cat. Lep. Alsace," 2nd Ed., ii., p. 166 (1882); Sorhagen, "Die Kleinschmett. Brandenbg.," p. 308 (1886); Hering, "Stett. Ent. Zeit.," lii., p. 220 (1891); Meyrick, "Handbook," etc., p. 717 (1895). *Aeneofasciata*, Frey, "Die Tineen," etc., p. 376 (1856); "Linn. Ent.," xi., p. 388 (1857); Heyden, "Stett. Ent. Zeit.," 1861, p. 39; Sta., "Nat. Hist. Tin.," vii., p. 148 (1862).

Original description.—1110. *Aeneofasciella* (*-ata*), Frey.—Nur 1 männliches, mir unbekannt. Wie eine ansehnliche *anomalella*, also zweiter Grösse. Deckel gross, Fühler schwarz. Vorderflügel kupferbraun, an der Wurzel messinggelb; Spitze etwas violett, Franzen dunkelgrau, Binde blaulich silberfarben, wie eine frische polirte Stahlklinge, gerade, vertikal, breit (Herrich-Schäffer, *Sys. Bear. der*

Schmett. von Europa, v., p. 353). Frey's diagnosis of *N. aeneofasciata* reads as follows: "Capillis atris, antennarum conchula alba; alis anter. dilute cupreo-æneis, nitidis, ad basim orichalceo-squamatis, fascia pone medium obsoleta, recta, lata, cæruleo-ænea, ciliis saturate griseis. $2\frac{1}{2}'''$" (*Die Tineen*, etc., p. 376). Heinemann, after redescribing the species, writes: "This species, which we at first took for new, since it did not agree with Frey's description, is, according to a written communication of the latter, the correct *N. aeneofasciella*, since his description was made from a pale captured specimen."

Imago.—Head velvety black. Anterior wings long, 5·6 mm. in expanse; the ground-colour golden-bronzy, the base purplish; a broad, vertical, silvery fascia beyond the middle, edged internally with a vertical fascia of a more violet-blue than the ground-colour; apex of the wing purple; the cilia purple at their bases, golden-brown in the middle, blackish-grey at their tips. The posterior wings and the cilia are also pale blackish-grey.

Egg-laying.—The egg is almost always placed on the underside of a leaf of *Agrimonia eupatoria* or *Potentilla tormentilla* (Wood).

Mine.—The first part of the mine forms an exceedingly slender and voluminous gallery, and, in this stage, is very like the mine of *N. aurella*. After the last moult it alters its practice, and then excavates a blotch. Heinemann says that the larva makes a strongly contorted mine, with a slender excremental track, that can hardly be distinguished from that of *N. agrimoniae*. Fletcher observes that in small leaves of *Agrimonia*, and in those of *Potentilla reptans* and *P. tormentilla*, the mine becomes a large blotch, occupying the whole, or nearly the whole of a leaflet. Nolcken writes: "The first part of the mine forms a narrow, slender, very slightly tortuous gallery, with a fine blackish frass-line, bordered on either side with pale margins. The last part of the mine is formed very similarly to that of the preceding species (*N. regiella*), but the frass is more distinctly granular, and tends to separate into distinct grains or heaps thereof. As a rule, the frass is so placed as to indicate the course of the gallery, but in other mines a somewhat long, round blotch is formed, the frass being heaped up at the base, where the widened gallery or blotch originates from the slender gallery which forms the first part of the mine. The blackish spot formed by this heaping of the frass appears darker at the centre, owing to the greater massing of the frass pellets there."

Larva.—The larva is yellowish in colour (Frey), very similar to that of *N. aurella* (Wood). Heyden describes it as follows: "Raupe glänzend, glatt, durchscheinend, einfarbig gelblichweiss. Kopf glänzend, gelb, mit gelblichbraunem Mund und nach vorn geschlossener Bogenlinie auf der Stirne" (*Stett. Ent. Zeit.*, xxii., p. 39).

Cocoon.—The larva deserts the leaf in which it has fed up in order to pupate (that of *N. agrimoniae*, which also feeds in leaves of *A. eupatoria*, spins its cocoon in the mine), and finally makes its cocoon on the surface of the ground. The cocoon is oval in outline, rather flat, and composed of silk of a reddish-brown colour (Heyden). Heinemann calls the cocoon almost circular, and says that it is yellowish-brown in colour.

Food-plants.—*Agrimonia eupatoria*, *Pontentilla tormentilla*, *P. reptans*, and rarely on *P. auserina* (Fletcher). *Tormentilla erecta* (Wocke).

Time of appearance.—This species is only recorded as being single-brooded. but the experience of Threlfall (*vide* below) goes to show that it is double-brooded. Frey obtained imagines in May, 1858, from larvæ found on October 25th, 1857, and Heyden, in the beginning of May, 1859, from larvæ found in the middle of October, 1858. Hodgkinson bred imagines on April 15th, 1877, from larvæ found the preceding autumn at Witherslack. Threlfall found larvæ at Grange on October 5th, 1878, and bred the imagines freely from May 5th-12th, 1879. From larvæ obtained July 21st, 1877, at Witherslack, he also bred imagines plentifully on August 17th of the same year. Fletcher discovered mines, at Abbott's Wood, on November 11th, 1888. Cambridge gathered larvæ in their mines as late as November, 1889. Sang's dates are October 17th, 1871, October 24th, 1873, July 16th and September 30th, 1874, September 24th, 1880, at Darlington; October 18th, 1878, at Castle Eden (*teste* Gardner). Nolcken records finding young larvæ on September 22nd, 1865, at Pichtendahl. He captured imagines on May 9th, 1866, at Sall, and on May 18th, at Pichtendahl.

Localities.—Devon: Paignton (Bankes). Dorset: Bloxworth (Cambridge), I. of Purbeck (Bankes), Glanvilles Wootton (Dale). Durham: Darlington, Castle Eden (Sang). Hereford: Tarrington (Wood). Kent: Folkestone (Webb). Lancashire: Grange and Lytham (Threlfall). Sussex: widely distributed, but not abundant, Cissbury, Worthing, Arundel, Hailsham (Fletcher). Westmorland: Windermere (Hodgkinson), Witherslack (Threlfall).

Distribution.—France: Creuse, Auvergne; Nohaut, Indre (Sand). Germany: Offenbach (Heyden), Frankfort-on-the-Main (Schmid), Wolfenbuttel (Heinemann), Friedland (Stange), Saverne, Alsace (Peyerimhoff). Russia: Sall, Pichtendahl (Nolcken). Switzerland: Zürich (Frey).

NEPTICULA TORMENTILLELLA, Herrich-Schäffer [? sp. Brit.]

Synonymy.—Species: *Tormentillella*, H.-Sch., "Correspondenzblatt.," 1860, p. 60; "Neue Schmett.," p. 167; Staud. and Wocke, "Cat.," p. 336 (1871).

Original description.—*Nepticula tormentillella*, H.-Sch.—Raupe in den Blättern von *Tormentilla erecta* unter jungem Nadelholz. Schmetterling an denselben Stellen Ende Mai ziemlich häufig. Scheitel schwarz, an den Seiten olivenbraun, keine Nackenschöpfe, Fühler schwarz, über halbe Flügellänge; Vorderflügel bis zur Mitte metallisch olivengrün, dann ein olivenbraunes Band, so breit als das vertikale silberne, etwas stahlblau glänzende bei $\frac{2}{3}$, dann eine kleine Spitze olivenbraun, von den dunkelgrauen, am Ende allmählig lichteren Franzen nicht scharf geschieden. Beine schwarzbraun. Der männliche After stumpf zweispitzig, jederseits mit kleinem schwarzen Pinsel. Der *marginicolella* am nächsten; diese ist aber plumper nicht olivengrün, sondern olivengold mit viel Purpurkupfer. Die Binde ist viel schräger, der After des Mannes ganz gelb, mit 2 grossen gelben Pinseln, der Spitze des Weibes schwarz (Herrich-Schäffer, *Correspondenzblatt für Sammler von Insecten*, etc., 1860, p. 60).

References to N. tormentillella as a British species.—This species appears to have been introduced and re-introduced into the British list without any real reason. The references are as follows: (1) Stainton notes (*Ent. Weekly Int.*, viii., p. 168) that Herrich-Schäffer had described *N. tormentillella* and other new species. He adds: "*N. tormentillella* is a widely distributed species, as we have found it at

West Wickham, Bideford and Dunkeld." (2) Stainton gives (*Ent. Weekly Int.*, viii., p. 176) a translation of Herrich-Schäffer's description. (3) Stainton writes (*Ent. Weekly Int.*, ix., p. 22): " *N. tormentillella* in the leaves of *Potentilla tormentilla*. This occurs at West Wickham, and probably in other localities near London." (4) Stainton states (*Ent. Ann.*, 1861, pp. 91-92) that he was about to announce the occurrence of *N. tormentillella* in England, as he had "bred a *Nepticula* from larvæ found in leaves of *P. tormentilla*, on Birnam Hill, Dunkeld, in September, 1859," that he had assumed this to be the *N. tormentillella*, H.-Sch., but that it was totally different. He adds: "Herrich-Schäffer's insect has the anterior wings metallic-greenish at the base, the fascia silvery, slender and slightly curved; my specimen has the base of the anterior wings brownish, the fascia is pale golden, rather broad, and nearly straight. It would be unsafe to found a species on this single specimen, but it is not improbable that more than one species may feed upon *Potentilla tormentilla*." (5) Sang describes (*E.M.M.*, xxii., p. 138) the mine of a *Nepticula* obtained near Newcastle-on-Tyne, in 1885, on *P. tormentilla*. After noting the similarity of the larva to that of *N. poterii*, he says: "Mr. Warren tells me that he bred *N. aeneofasciata*, last year, from a mine on the same plant, but this certainly is not that species. Mr. Stainton also found a mined leaf in Scotland, some years ago, from which he bred an imago, which he cannot refer to any species with which he is acquainted. Should this not be *N. tormentillae* (*sic*), a Continental species, it will most likely prove to be new to science." (6) Bankes, under the title of "*Nepticula tormentillella* in Yorkshire and Westmorland," writes (*E.M.M.*, xxiv., p. 160): "It seems now to be generally accepted, as a fact, that the *Nepticula* referred to by the late Mr. John Sang, in the *Ent. Mo. Mag.*, xxii., p. 138, is identical with the Continental *N. tormentillella*," etc. He then goes on to describe the mine and larva of a *Nepticula*, found by him in Yorkshire and Westmorland, on *P. tormentilla*. (7) Threlfall says (*Ibid.*, pp. 186-187) that he has bred the *Nepticula*, feeding on *Potentilla tormentilla*, from larvæ found on the moors of Westmorland, that these were not *N. tormentillella*, but were identical with the specimen bred many years before by Stainton from larvæ found near Dunkeld, and suggested that the species wanted a name. (8) Stainton named (*Ibid.*, p. 260) the species noticed by Threlfall, *serella*, and stated that he had had the Dunkeld specimen, Sang's Newcastle specimens, and Threlfall's specimens, before him at the same time, and found them identical. (9) Bankes states: (*Ibid.*, xxvii., p. 196) that his note in vol. xxiv., p. 160, should refer entirely to *N. serella*. (10) Hodgkinson wrote (*Ent.*, xxii., p. 219) that from mines obtained in *Tormentilla officinalis*, at Windermere the previous October, he was "breeding a very distinct-looking *Nepticula*. The larvæ were of a deep yellow colour; the mines were conspicuous, and there were several on a plant. The sexes of the moth are of the same type, but the female is much larger than the male. This species should be the *N. tormentillella* which was expunged from our lists in favour of *N. serella*. The specimens are as large again as those of *N. serella*. I may add that the species, which I will call *N. tormentillella*, is exceedingly local, although the food-plant is plentiful enough in some of the woods." (11) Bankes writes (*in litt.*, June 28th, 1898), that he has compared Hodgkinson's specimens with the Continental series of Frey, etc., and finds them to be *N. aeneofasciella* and *N. serella*.

We may, therefore, safely conclude that *N. tormentillella* has no *locus standi* in the British fauna.

NEPTICULA AURELLA, Fabricius.

Synonymy.—Species: *Aurella*, Fab., "Sys. Ent.," p. 666, no. 65 (1775); "Ent. Sys.," iii., 2, 329, no. 180; Göze, "Ent. Beitr.," iii., 4, 152, 211 (1783); Gmelin, "Sys. Nat.," i., 5, 2605. 1269 (1788); Villers, "Ent. Faun. Suec.," ii., 503, 975 (1789); Turton, "Sys. of Nature," iii., 2. 378; Haw., "Lep. Brit.," p. 584 (1828); Stephs., "Illus.," iv., 268 (1835); Zell., "Linn. Ent.," iii., p. 306. in part (1848); Sta., "Cat. Lep. Tin.," p 28 (1849); "Trans. Ent. Soc. Lond.," v., p. 129 (1847); "Ins. Brit.," p. 305 (1854); "Nat. Hist. Tin.," i., p. 34, pl. i., fig. 1 (1855); "Man.," ii., p. 438 (1859); H.-Sch., "Sys. Bearb.," v., p. 350 (1855); Frey, "Linn. Ent.." xi., p. 441 (1857): Werneburg, i., p. 567 (1864); Healy, "Ent., Mo. Mag.," iii., pp. 7 *et seq.* (1866); Staud. and Wocke, "Cat.," p. 337 (1871); Mill., "Cat Lep. Alp. Mar.," p. 372 (1875); Heinemann and Wocke, "Schmett. Deutsch.," p. 742 (1877); Sand, "Cat. Lep. Auv.," p. 201 (1879); Snellen, "Vlinders," p. 983 (1882); Peyer., "Cat. Lep. Als.," ii., 2nd Ed., p. 165 (1882); Hering, "Stett. Ent. Zeit.," lii., p. 220 (1891); Meyrick, "Handbook," etc., p. 717 (1895).

Original description.—*Tinea aurella*, alis auratis, postice atris; fascia argentea. Minima facile omnium. Caput album, fronte ferruginea. Antennæ breves, nigræ. Alæ auratæ, nitidissimæ, postice atræ, qui colores striga argentea vivacissima distinguuntur [Fabricius, *Systematica Entomologica*, p. 666, no. 65 (1775)].

Synonymic notes.—Werneburg, Heinemann, Wocke, Sorhagen, and others do not accept the Fabrician description of *N. aurella* as applying to this species. Werneburg (*Beiträge zur Schmett.*, i., p. 567) argues at length against the possibility of *aurella*, Fab., being *aurella*, Sta., and determines it for *N. plagicolella*, Sta. His arguments against its being *aurella*, Sta., are: (1) The latter is too large. Fabricius would not have called it "minima facile omnium." (2) *Aurella*, Sta., lives on *Rubus*, hence Fabricius would hardly have found it among fruit trees. (3) *Aurella*, Sta., appears to be very rare in Germany. None of these arguments is particularly strong. Of them we would say: (1) *Aurella* was the only Nepticulid described by Fabricius, and would be the smallest moth known to him. (2) The imagines of this species occur on the trunks of various kinds of trees growing near brambles. (3) Although rare, the species is taken in Germany. Stainton, whilst accepting the Fabrician description. as applying to the present species, says (*Nat. Hist. Tin.*, i., p. 46): "There is nothing in the Fabrician description to apply it in preference to any of the allied species. It is true the wings are not 'black' posteriorly, it is true the fascia had better be described as pale golden; but none of the species with silvery fasciæ have the 'wings golden.' The 'head white, in front ferruginous.' evidently alludes to the whitish eye-caps at the base of the antennæ on each side of the reddish tuft of the head. The 'occurs among orchard trees,' might, certainly, if interpreted too rigidly, restrict us to an apple or plum-feeding species; but the allusion is, no doubt, to the perfect insect having been taken on the trunk of some orchard tree, which is not an improbable locality for a bramble-feeding species." It appears necessary, however, since so many authorities refuse to accept the Fabrician description, as applicable to this species, to give

Stainton's description, to which these entomologists refer as the earliest with which this species can be with certainty connected. This reads as follows: "*Aurella*, Fab., Haw., St. ♀ *Aurella*, Zell., 306. *Hübnerella*, Hbn., 236; Zell. (*Isis*, 1839).—Basal half of the anterior wings golden, apical half violet; in this is a very shiny silvery fascia placed rather obliquely and slightly concave towards the base; head ferruginous" (*Catalogue Lep. Tin.*, p. 337).

IMAGO.—Head ferruginous. Anterior wings 6-7 mm.; golden brown in colour, tinged with purple beyond the middle; apex of the wing deep violet; just beyond the middle is a nearly straight, oblique, pale golden fascia. Posterior wings and cilia dark grey.

EGG-LAYING.—The egg is laid on the under (rarely on the upper) surface of a bramble leaf (Stainton). The egg is always laid upon the upper side of a leaf (Wood).

MINE.—The mine consists of an irregular, not contorted, wavy gallery of moderate width. It is at first greenish-white in colour, with a line of black excrement along the centre.

LARVA.—Length 2 lines; clear amber-yellow, shining and transparent; the head a little darker, the mouth and two slender lines receding from it reddish-brown; the dorsal vessel shows through the skin, and is dark greenish-brown in colour (Stainton). When the larva is quite full-fed, the dorsal vessel loses its green appearance, but the organ can be traced by its faint brownish outlines. The full-fed larva is almost exactly four lines in length, and rather more than half a line in width (Healy). The larva mines with the dorsal surface uppermost (Wood).

MOULTING OF THE LARVA OF N. AURELLA.—For our knowledge of the facts connected with this portion of the life-history of *N. aurella* we are indebted to Healy, who writes: "I noticed that it was rarely that any two larvæ agreed in their markings during the period of moulting, and in some few instances the differences were very great. One particular larva was collected in the last week of January, 1863. The day after I had it in my possession it left off feeding, and remained perfectly quiescent in its mine, when all the colour and markings on the head disappeared, and on the anterior portion of the body of the larva were two reddish-brown lines, at an angle of about 60°, and ending with a dull red blotch, the head and all the parts of the body situate between the two angular lines having a semi-transparent appearance; the remainder of the body was dull yellow, the dorsal vessel being invisible. In this position the larva remained for the space of ten days. At the end of the first week in February, the mouth of the larva became brown, and on the back of the second segment there appeared a square, dull reddish patch. The next day the back of this segment became decorated with two faint brown triangular spots, margined with darker; these two triangular spots were followed by a couple of longitudinal lines, having a dull reddish blotch at their bases (the dull red blotch at the ends of the two reddish-brown lines had then disappeared). Two days later a pair of reddish-brown spots became visible on the back of the second segment, and were immediately followed by a small reddish blotch. On February 10th the entire surface of the mouth turned dark brown, and all the various spots and markings on the anterior portion of the body of the larva became merged in one general dull blotch. The larva then recommenced feeding, but at first very slowly, and appeared to be in a very weak and languid state. As the food passed into the stomach, the anterior portion of the dorsal vessel (which before the larva began feeding was invisible) became tinged with green, and after a short interval its posterior portion assumed a darker tinge. As soon as the larva had refreshed itself with a little food, it rested for a time, and during this interval threw off the old covering of its head. (On one occasion, as soon as a larva began feeding, after moulting, I watched it narrowly from the instant it swallowed the first mouthful of food to the moment it ejected the first pellet of "frass," and found that it occupied precisely half-an-hour, thereby implying that it requires that amount of time, after deglutition, for the food to be digested, the nutritious properties extracted, and the coarse indigestible portion finally ejected as frass.) After this partial moult, the larva, as if trying to make up for lost time, fed with remarkable rapidity, its jaws being in constant motion, and as it ate its way forwards, the anterior portion of its body became stouter. By this time the larva had fed for a space of six hours, and had so far extended its mine as to enable it to withdraw half of its body from its old skin; the frass then gradually began to accumulate in the partially thrown-off skin, the latter serving as a receptacle in which the "frass" was deposited, and as the larva moved the extremity of its body about within the walls of its old skin, the frass was distinctly observable as it fell pellet by pellet. The frass did not flow in a continuous line to the extremity of the body of the larva, but appeared in pellets at the base of the antepenultimate segment; each pellet then slid gradually down till it arrived near the centre of the penultimate segment, when it seemed to be taken in charge by the branched portions of two darkish coloured muscles, and conducted to the point where the remaining portions of the muscles lay parallel with each other down the posterior portion of the penultimate and the anterior portion of the anal segments; these muscles then immediately expanded, and received the pellet of "frass," and guided it to their extremities, and then deposited it near the middle of the anal segment, out of which it gradually slid, and became intermixed with the other pellets of frass in the mine. At the expiration of twelve hours, the larva succeeded in entirely escaping from its old integument; the frass, instead of forming a continuous line down the centre of the mine as it had done before the larva moulted, then assumed a scattered appearance; this change in its arrangement arising from the larva jerking its posterior segments about each time it deposited a pellet of frass" (*Entom. Mo. Mag.*, iii., p. 28).

Cocoon.—The cocoons vary much in size, from 2 mm. to 4 mm. in length, and from 1·5 mm. to 2·5 mm. in width. The cocoon is roughly oval in outline, but varies much in actual shape, some having the two opposite ends almost equal, others with one end much wider than the other. The colour, too, is variable, dull-brownish with a faint greenish tinge is the most common tint, but some cocoons are quite green, whilst others incline to yellow-ochreous. The rim is somewhat thinned off, but does not form a flattened flange, the strongly domed part of the cocoon rising gradually from the margin to the highest point, which is almost central. The edge of the rim is crenate, and has a considerable quantity of loose flossy silk around it. The raised part of the cocoon is moderately smooth, and only very faintly reticulated with fine lines of a tint just darker than the cocoon itself. [Described July 5th, 1898, under a two-thirds lens from cocoons sent by Mr. W. H. B. Fletcher.] When the larva is full-fed, it gnaws a hole, exactly of the same shape and form as the front and sides of the head of the larva, and gradually draws its body from the mine. It then seeks a suitable place in which to make its cocoon ; this is sometimes spun on a leaf or twig, sometimes on a dead leaf on the ground, and larvæ have been known to penetrate the sand in a breeding-cage to the depth of an inch or more, and there spin their cocoons. When it has selected a suitable position, it commences carpeting with silk the part of the leaf or twig on which it is resting, and thus forms the floor of its cocoon. This being done, the larva, keeping its body in an apparently cramped position, gradually throws a number of silken filaments over its body, fastening them to the sides of the floor of the cocoon, thus giving a convex form to the structure. This forms the framework of the cocoon, but by continuous spinning it is entirely completed in about nine hours (Healy). The cocoon is of an irregular shape, rather flat, with scalloped edges, and varies in colour from pale dirty-green to pale brown. The pupal state lasts about three weeks (Stainton). The cocoon is whitish-green, with a flat angulated margin (Hind).

Quiescent period preceding pupation.—The body of the larva is curled round in the newly-formed cocoon, and occupies nearly the whole of its interior. A fortnight later its body is much shrunk, so that it lies in the centre of the cocoon with much room to spare. At this time, the larva is only 2‴ long and 1‴ wide at its stoutest part, having lost just half its length by the peculiar shrinking process it undergoes; its body is also of a paler yellow than when it constructs its cocoon. The larva is now quite motionless, but, a day or two afterwards, the head becomes slightly swollen, and gradually the four anterior segments assume the same swollen appearance; the posterior segments also become slightly swollen, but not nearly so much so as the four anterior segments. The anterior segments continue to swell until they commence to crack, and the skin slowly contracting, the pupal state is assumed. The larval skin is ultimately collected in a little heap at the posterior end of the pupa (Healy).

Pupa.—The newly formed pupa presents a very pretty appearance, the head, thorax and wing-cases being enclosed, as it were, in a covering resembling very thin white glass, the abdomen being of a pale sulphur-yellow; the pupa is then exceedingly tender, and can only be touched with the greatest caution. About three-parts down the dorsal surface of the abdomen a pale brown patch is observable, and on the back of the head are two parallel chains of dusky-coloured dots; after two days the eyes become pale brown, and the two parallel chains of dusky spots disappear, their place being occupied by a pale reddish patch, and three little dark spots visible near the base of the thorax. The colour of the abdomen gradually deepens to orange-yellow; the next day the spots near the base of the thorax disappear, and also the brown patch on the abdomen. The pupa, which has hitherto remained inactive, now wriggles its abdomen about, and its surface becomes much firmer. About a week later, the brown abdominal patch reappears and shows through the ventral surface, whilst two short projections, which proved to be the ends of the wing-cases, and which had been previously noticed gradually retiring over the sides of the pupa, are to be observed at the posterior end of the abdomen; the eyes then turn quite black, and the ventral surface of the pupa is partially slit open, whilst down the centre of the crack several dusky spots become dimly traceable. The next day a rather thick streak appears down the centre of the thorax, and two days later this streak is crowned by a little circular dusky spot; the brown patch on the dorsal surface of the abdomen shrinks lower down, and the feet of the future imago slowly begin to separate themselves from the pupa; the following day the dusky streak which had appeared three days previously, down the centre of the thorax, becomes reduced to a mere line, and instead of the little dusky spot, the position of the latter is occupied by two short parallel lines, whilst a small cluster of three dusky spots also appears on the centre of the abdomen. Later, the thorax becomes free of all markings, and the abdominal markings also practically disappear. After seven days a dark spot becomes observable on each side of the base of the thorax; these spots gradually enlarge, and finally become blended into one dark-coloured blotch, which slowly spreads over the thorax, head and wing cases, turning them shining black, after which the deep colour spreads to the abdomen, although the latter only becomes slightly discoloured in comparison with the head, thorax and wing-cases, on which the usual markings of the imago gradually make their appearance. The pupa, whose changes in appearance have been thus detailed, produced an imago the next day, April 3rd, 1866 (Healy).

Parasites.—Healy states that the larva of *N. aurella* is subject to the attack of a Hymenopterous parasite, and notes that the parasitic larva emerging at the back of the head of the Nepticulid larva, applies its mouth to the hole through which it emerged, and proceeds to absorb the juices of its victim, till there is nothing left of the unfortunate Nepticulid larva but the dry empty skin. The parasitic larva is then full-fed, fat and plump, there being just sufficient nourishment in the body of one larva of *N. aurella* to supply it with the proper amount of food.

Food-plant.—Chiefly (if not entirely) in evergreen bramble, *Rubus fruticosus*. [Before *N. fragariella*, *N. gei* and the allied species were separated from *N. aurella*, many other food-plants were recorded, *e.g.*, Stainton gives: *Rubus fruticosus*, *R. idaeus*, *Geum urbanum*, *Fragaria vesca* and *Agrimonia eupatoria*. Wood still allows as many (or rather more) food-plants, not acknowledging the specific distinctness of *N. fragariella* and *N. gei*; he gives: bramble, strawberry, agrimony, *Spiraea ulmaria*, ? raspberry, ? dewberry, ? *Geum*.]

Time of appearance.—The species is continuously brooded whilst the temperature is suitable for its proper growth and emergence. Jordan found a newly-emerged imago on February 3rd, 1890, on a bramble leaf at Teignmouth. Farren says: "Larvæ may be found at all times in the neighbourhood of Cambridge, and the moths bred accordingly." Corbett says: "Full mines may be obtained at Doncaster, from October to February," and Atmore has found larvæ in their mines at King's Lynn, "in November, December and January." Stainton found larvæ at Lewisham, on April 4th, 1852, and he further reports "an undoubted *N. aurella* bred from *Agrimonia eupatoria*, on March 4th, 1861, from a larva received from Healy, on

October 21st, 1860." Stainton also found larvæ at Monte Maris, nr. Rome, on March 14th, 1866. Threlfall records imagines on June 9th, at Witherslack, and Durrant on July 16th, 1896, at Barcote. The following list, however, of specimens captured at large by Stainton, shows its continuous broodedness: April 4th, 1848, at Lewisham; May 26th, 1848, May 21st, 1850, at Lewisham; May 17th-18th, 1851, at Beckenham; June 9th, 1848, at Beckenham; June 20th, 1849, at Lewisham; June 24th, 1871, at West Wickham; July 21st, 1849, at Lewisham; July 25th, 1849, at Mickleham; August 25th, 1851, at Lewisham. Bred specimens are recorded as follows: February 22nd, 1853, April 17th-20th, 1853, April 30th, 1855, May 5th-11th, 1852, May 7th, 1853, September 21st, 1853, November 16th, 1851 (from larva full-fed October 19th, 1851, that formed a white cocoon); December 2nd, 1862, December 7th, 1852, all from Lewisham larvæ.

Localities.—Aberdeen: rather scarce (Reid). Berkshire: Barcote (Durrant), Reading (Hamm). Cambridge: Cambridge, common (Farren). Cheshire: Birkenhead (Stainton); abundant everywhere (Ellis). Derby: Burton (Sang). Devon: Dawlish (Stainton), Teignmouth (Jordan). Dorset: Bloxworth (Cambridge), Purbeck (Bankes), Glanvilles Wootton (Dale), Portland, Weymouth (Richardson). Durham: Darlington (Stainton). Fermanagh: Enniskillen (Partridge). Gloucester: Bristol (Vaughan). Herts: Cheshunt (Boyd). Hereford: Tarrington (Wood), Leominster (Hutchinson). Kent: Lewisham, Tenterden and West Wickham (Stainton). Lancashire: Manchester (Stainton), Southport (Hodgkinson), abundant everywhere (Ellis). Leicester: Market Harborough (Matthews). Norfolk: Norwich, Merton, probably everywhere in county (Barrett), King's Lynn (Atmore). Northumberland: Newcastle (Stainton). Somerset: Castle Cary (Macmillan). Suffolk: Leiston (Walsingham). Surrey: Mickleham (Stainton), Haslemere (Barrett). Sussex: generally distributed and common in Sussex, Worthing, Bognor, etc. (Fletcher), Guestling (Bloomfield), Lewes (Stainton). Westmorland: Witherslack (Threlfall). Worcester: Worcester (J. E. Fletcher). Yorkshire: York, plentiful (Hind), Doncaster, abundant (Corbett), Scarborough (Stainton), Harrogate and Richmond (Sang), Huddersfield (Inchbald), Sheffield (Doncaster).

Distribution.—Generally distributed in the British Islands, but not so general on the continent of Europe. Meyrick writes: "Central Europe and N. Africa." France: Mentone (Stainton), Nohaut, Indre (Sand), Alpes-Maritimes (Millière). Germany: Bonn (Frey), Sandsee (Hering). Italy: Central Italy (Wocke), Leghorn and Montenero (Mann); Monte Maris, nr. Rome, nr. Florence (Stainton). Netherlands: Friesland (Snellen). Frey writes: "I have only seen a single Continental specimen of *N. aurella*, which was taken near Bonn. It does not occur at Zürich."

NEPTICULA FRAGARIELLA, Hein. and N. GEI, Wocke.

Wocke described (*Catalog*, etc., p. 336, no. 3005) a species under the name of *N. gei*. This, in his continuation of Heinemann's *Schmett. Deutsch.*, p. 740, he sinks as synonymous with *N. fragariella*, Heyd., stating that he no longer finds differences between the specimens bred from *Fragaria* and *Geum rivale*. He says that the specimens vary in glossiness, in the colouring of the basal part of the fore-wings, the colour of the head, and in the width of the dark purple-brown band preceding the metallic band. The variation in the mines, he considers, may be explained by the differences in the food-plant. He then states that he believes *N. nitens*, Fologne, the larva of which feeds on *Agrimonia*, to be referable to the same species. Eppelsheim was inclined (*Stett. Ent. Zeit.*, li., pp. 229-235) to separate them on the following grounds:—

(1) The basal area of fore-wings greenish-brassy in *N. fragariella*, deep golden-brown in *N. gei*.

(2) The colour of the metallic band slightly golden in *N. fragariella*, silvery in *N. gei*.

(3) Head hairs in *N. fragariella*, ♂ dark, ♀ reddish; in *N. gei* sometimes blackish, sometimes red.

(4) The colour of the cocoon of *N. fragariella* light red, of *N. gei* dirty-greenish or yellowish-grey.

(5) The gallery of the mine whitish, with sharply defined, continuous frass-line, and wide margins in *N. fragariella*; the gallery not so pale, the frass more scattered, the mines with less defined margins in the mine of *N. gei*.

(6) The imago of *N. gei* is larger, the largest examples measuring 6 mm.; the largest *N. fragariella*, 5 mm.

In spite of these differences, Eppelsheim was unable to satisfy himself that they were absolutely fixed, except in the matter of the cocoons and the greater average size of *N. gei*, and he was, therefore, inclined to agree with Wocke's conclusions, and unite them as the same species. He, however, stated that he considered the *Geum* feeder should retain its name, and later (*Stett. Ent. Zeit.*, lii., p. 351) he described a new aberration as *N. gei* ab. *semicolorella*. Durrant says that "English *N. fragariella* (from Sang) appear to have the white cilia more developed (*i.e.*, carried round to the costal cilia), while the colour seems to stop short before (or about) the apex in Continental *N. gei*. English *N. fragariella* are smaller than Continental *N. gei*."

We do not think the last has yet been written of this puzzling group, and hence keep the species separate, only noting here that Wocke and Eppelsheim write—*gei*, Wk. = *fragariella*, Hein., and that Wood writes—*gei*, Wk. = *fragariella*, Hein. = *aurella*, Fab.

NEPTICULA FRAGARIELLA, Heinemann.

SYNONYMY.—Species: *Fragariella*, Hein., "Wien. Monats.," 1862, p. 263 (pubd. Aug., 1862); Heyd., "Stett. Ent. Zeit.," 1862, p. 365 (pubd. Oct., 1862); Hein. and Sta., "Zool.," 1863, p. 8363; Sta., "Ent. Ann.," 1868, p. 45; Staud. and Wocke, "Cat.," etc., p. 336 (1871); Hein. and Wocke, "Schmett. Deutsch.," pp. 739-740 (1877); Sorhagen, "Die Kleinschmett. Brandbg.," p. 344 (1886); Hering, "Stett. Ent. Zeit.," lii., p. 220 (1891); Meyr., "Handbook," etc., p. 717 (1895). ? *Gei* (*teste* Wocke and Eppelsheim).

ORIGINAL DESCRIPTION.* — *Nepticula fragariella*, Heyd. — Capillis fuscis, antennarum conchula argentea; alis anterioribus basi late viridi-æneis, ante et post fasciam latam dilute auream purpureo-fuscis, ciliis fuscis, apice griseis. Exp. al. 2-2⅓ lin. Von Heyden *in litt.* Die Kopfhaare braun, in der Mitte schwärzlich, an den Seiten und vorn in Grau übergehend, die Augendeckel klein, bei dem Manne etwas grösser, grünlich weiss mit Metallglanz, die Fühler in beiden Geschlechtern von mehr als halber Flügellänge, schwärzlich, die Palpen weiss. Lichte Nackenschöpfe sehe ich nicht. Der ganze Körper grünlich erzfarben, glänzend, auch die Beine, doch sind diese dunkler, der After bei dem Manne mit zwei kleinen, hellgrauen Pinseln. Die Vorderflügel sind schmal und gestreckt, ziemlich gleichbreit, bis etwas über das Wurzeldrittel hinaus grünlich messingfarben, stark glänzend, der übrige Theil bis zur Spitze hat eine ziemlich hellbraune, etwas auf Purpur oder Veilbraun, seltener auf Veilblau ziehende Färbung, welche vor der Metallbinde als eine ebenso breite, wurzelwärts bestimmt, doch nicht scharf begrenzte Binde erscheint. Die Metallbinde steht vertical bei $\frac{2}{3}$, ist ziemlich breit, licht golden und stark glänzend. Die Fransen haben an der Wurzel braune, etwas violette Schuppen, die aber nicht bestimmt begrenzt sind, an der Spitze sind sie, sowie die Hinterflügel und deren Fransen hellgrau. Auf der Unterseite sind alle Flügel hell bräunlich grau (Heinemann, *Wien. Ent. Monats.*, p. 263). Heyden's description reads as follows: "Capillis nigro-fuscis; conchula flavescens; alis anterioribus elongatis, angustis, nitidis, nigris, basin versus cupreis, fascia post medium aureo-argentea, nitidissima; tarsis griseis. *Varietas*: Capillis anticis rufis.* Exp. al. $2\frac{1}{2}$-$2\frac{2}{3}'''$. Schopf des Schädels schmal, ziemlich glatt, schwarzbraun. Palpen lang behaart, braungelb, an den Seiten schwarz. Augendeckel gross, gelblich. Fühler schwarz mit etwas hellerer Spitze. Flügel lang, schmal, fein beschuppt, glänzend, schwarz mit etwas Kupferglanz; Basis bis zu $\frac{1}{3}$ der Flügellänge lebhaft kupferröthlich und etwas schwarzem Unterrand; hinter der Mitte in der schawarzen Grundfarbe eine stark glänzende, goldsilberne Querbinde, die wegen der geringen Breite der Flügel fast so breit als lang ist und daher einen fast viereckigen oder hinten etwas verschmälerten Fleck bildet. Der schwarze Raum vor der Binde ist fast so breit als diese. Franzen breit grau. Hinterflügel mit ihren Franzen grau. Halsschild kupferroth. Hinterleib schwarz mit metallischer Beimischung und röthlichen Haaren an der Spitze. Tarsen grau behaart. Die Färbung des Kopfes ist in beiden Geschlechtern gleich; doch habe ich unter den andern ein kleines weibliches Exemplar gezogen, bei welchem die vorderen Haare des Schopfes fuchsroth sind. Es zeichnet sich diese Art von allen mir bekannten durch die auffallend langen und schmalen Vorderflügel aus" (Heyden, *Stett. Ent. Zeit.*, xxiii., pp. 365-366).

---

* There is some difficulty in settling which is the original description of this species. Heyden published a description in the *Stettin. Ent. Zeitung*, 1862, p. 365, in the part dated July—Sept., hence probably not actually published until October, 1862. Heinemann, in the *Wien. Monats.*, August, 1862, p. 263, calls it *fragariella*, Heyd., but distinctly cites it as "Heyden *in litt.*" There is, we think, no doubt that Heinemann's was the first description published. We, however, give both descriptions.

Imago.—Head brown, but blackish in the middle of the frontal tuft, and grey at the sides and in front. Anterior wings 5 mm., narrow, elongate, nearly uniform in width; basal third bronzy-green, the remaining area pale brown, with purple tinge; transverse metallic fascia two-thirds from the base, rather broad, pale golden, shiny, edged internally by an almost equally broad, purplish transverse fascia; cilia brownish-purple with pale grey tips. Posterior wings and cilia pale grey (Heinemann). Compare with note on p. 236.

Sexual dimorphism.—Heinemann says that the male has two small pale grey anal tufts that are wanting in the female.

Comparison of N. fragariella and N. splendidissimella.—*N. fragariella* bears, perhaps, some resemblance to *N. splendidissimella*, but can easily be distinguished from it. The latter has the frontal tuft deep black, the eye-caps larger, and the colour of the broader anterior wings beyond the brassy basal portion is quite different, being golden-brown with a strong violet tint, often almost entirely deep violet-blue, and not distinctly margined towards the pale base, but shading gradually into it; besides, the metallic fascia is nearer the base on the costa, and perceptibly oblique (Heinemann).

---

* Probably there is considerable variation in the colour of the head of this species, those we have examined, however, have had "red" heads.

COMPARISON OF SUPPOSED BRITISH NEPTICULA FRAGARIELLA WITH N. DULCELLA AND N. GEI.—The few British specimens that we have seen bred from *Fragaria vesca*, and that we take to be *N. fragariella*, have scarcely exceeded 4 mm. in wing expanse, have distinct reddish-ochreous (almost yellow-ochreous) heads; the base of the fore-wings brassy-green, the transverse fascia rather silvery than pale golden, the latter running through a purple-brown area that occupies the outer two-thirds of the fore-wings. Wood's *N. dulcella* are rather less in size, barely 4 mm., the head reddish-ochreous (almost yellow-ochreous); the base of the fore-wings brassy, the transverse fascia silvery, but more concave on inner margin, the purple-brown area even more extended than in *N. fragariella*. The imagines bred from *Geum urbanum* average 6 mm. The males have, usually, golden-yellow heads and whitish antennal bases, the females deep ferruginous or orange-fuscous heads; the basal area of the fore-wings is bronzy-purplish (not greenish), the fascia distinctly pale golden, the outer two-thirds bright dark purplish and not purplish-brown, the dark area within the transverse band narrower. The imagines from *Rubus corylifolius* are somewhat similar to those from *Geum*, but the males have the base of antennæ yellowish, the base of the fore-wings bronzy-purple, the transverse band rather broader and more oblique, and the apex brighter and more violet, perhaps blue-black is a better term.

EGG-LAYING.—The egg is laid on the upper side of a leaf of *Fragaria vesca* or *Agrimonia eupatoria*, usually by the side of one of the lateral ribs.

MINE.—The mine is very long and twisted many times. It commences very finely, and then for a considerable distance retains the same width; it is yellowish-grey in colour, with a darker, central, excremental track. Sometimes, two or three larvæ mine in the same leaf, the mines forming a dense tangle (Heyden). Heinemann describes the mine as long, narrow and tortuous, with a rather slender excremental line. According to Eppelsheim, there are considerable differences in the mines of *N. fragariella* in *Fragaria*, some showing the characteristic sharply defined frass-line only in the first and last parts of their course, the frass being much more loosely deposited in the middle part. He further notes that the mines in *Agrimonia eupatoria* resemble much more closely the mines of *N. fragariella* in *Fragaria*, than those of *N. gei* in *Geum*, probably because the *Agrimonia* is more closely allied to *Fragaria* than *Geum*. Our own notes, from a long series of mines kindly sent by Mr. W. H. B. Fletcher, are as follows: The mine is *very* much finer than that of *N. gei*, shorter, and with more small convolutions. The total length of the longer mines does not exceed three inches, not more than half the length of an average mine of *N. gei*, and it is not above half the width of the latter, and the blistered appearance of the leaf above a mine of *N. gei* is practically absent in the mine of *N. fragariella*. The frass forms an exceedingly slender continuous thread through the centre of the mine, from its commencement to its end, in some, however, with a slight tendency to the separation of the pellets in the middle part of the mine. This mode of disposal of the frass leaves a very clear margin on either side, causing what appears to be a fine, white, convoluted path on the upper side of a leaf, but quite invisible on the lower side, unless held against the light. In some of the mines, in leaves of *Agrimonia* *eupatoria*, the frass-track is markedly continuous; on the other hand, one example shows a considerable spreading of the frass pellets throughout its course. We quite agree with Eppelsheim that the mines in *Fragaria* and *Agrimonia* are very similar.

Larva.—The larva is shining, unicolorous, brownish-yellow, with the head and prothorax more shining and rather darker; on the head are to be seen (as in the allied species) two diverging darker lines; the mouth is also darker (Heyden). Heinemann notes the larva as "pale amber-yellow, with the head brownish."

Cocoon.—The cocoons (2) average 2·5 mm. long and 2 mm. wide. They are of an orange-yellow colour, rather paler, perhaps, than those of *N. dulcella*; the surface is moderately smooth, and is covered with a fine branching reticulation, red-brown in colour. The outline of the cocoon is an almost regular oval, with scarcely a shade of difference in the two ends. There appears to be no lateral flange, but a series of silken threads branch off all round the edge, evidently for the attachment of the cocoon. The pupa-skin is perfectly transparent, quite glossy, or watery-looking, on the thoracic and abdominal segments, wings greyer. There is a distinct stellate structure (a series of depressions internally) on the centre of the mesothorax. [Described June 15th, 1898, under a two thirds lens, from cocoons sent by Dr. Wood.] Heinemann describes the cocoon as "rather broad, flat, and of a brownish-yellow colour."

Food-plants.—*Fragaria vesca*, *Agrimonia eupatoria*.

Time of appearance.—Heyden found larvæ at the end of October, on the hill-slopes of the Bergstrasse, at Jugenheim. The imagines commenced to emerge (in a warm room) as early as the end of March. Heinemann says that the larva feeds in July, and again at the end of September and beginning of October. Bower found the imagines flying in the morning sun, on March 29th, 1894, at Chislehurst.

Localities.—The species is probably generally distributed over a large part of the country, but much confused with *N. aurella*. The only recorded localities are:—

Durham: Darlington (Sang *teste* Durrant). Hereford: Tarrington in *Fragaria* (Wood). Sussex: Balcombe in *Agrimonia*, Arundel in *Fragaria* (Fletcher).

Distribution.—Germany: Jugenheim, Frankfort-on-the-Main, Black Forest (Heyden); Wolfenbuttel (Heinemann), Alt Damm, Friedland (Hering).

NEPTICULA DULCELLA, Heinemann (? sp. Brit.).

Synonymy.—Species: *Dulcella*, Hein., "Wien. Monats.," 1862, p. 267; Hein. and Sta., *Zoologist*, 1863, pp. 8367-8; Staud. and Wocke, "Cat.," p. 337 (1871); Hein. and Wocke, "Schmett. Deutsch.," p. 746 (1877); Hutchinson, "List of Heref. Lepidop.," p. 16 (? 1893).

Original description.—*Nepticula dulcella*. Capillis ferrugineis, antennarum conchula luteo-alba; alis anterioribus dimidio basali olivaceo-æneis, subnitidis, postice atro-purpureis, fascia post medium recta, argentea nitidissima, ciliis apice griseis. Exp. al. 2⅓ lin. (Heinemann, *Wien. Monats.*, 1862, p. 267). To this Heinemann adds the following remarks: "Very like *N. continuella*. I can only find a difference in the paler colour of the anterior wings, and in the narrower dark fascia which precedes the silvery fascia being more obsolete towards the base. The anterior wings are pale olive-bronze from the base, rather glossy; they become gradually darker towards the silvery fascia, and before it become for an undecided extent dark brown, with faint purple-violet gloss; this is also the colour of the space between the fascia and the apex. The protruding scales in the cilia are dark violet; they lie in two rather regular rows, of which the outer one is the paler; the tips of the cilia are grey. The posterior wings are rather paler than in *N. continuella*. I have a pair bred from mines in strawberry leaves, which I could not distinguish from the mines of *N. fragariella*. The male I sent to Frey, who referred it to *N. fragariella*, remarking that the sexes of that species differ considerably. I have myself received *N. fragariella* from Heyden. It is the species already described (p. 263), and of which Buckheister and I have bred both sexes of quite similar specimens; likewise of *N. dulcella*, I have bred both sexes, which also agreed precisely, only that the male, as far as I remember, had more the colour of *N. marginicolella*, ♀. Moreover, all the specimens of *N. fragariella* appeared in the warm room, in January, whereas those of *N. dulcella* do not appear till March, simultaneously with *N. angulifasciella*; hence, I believe, I most decidedly recognise in this a new species."

N. DULCELLA AS A BRITISH SPECIES.—This species is found in Hutchinson's "List of Herefordshire Lepidoptera," for the micros mentioned in which, Dr. Wood is mainly responsible. He states that the insect here referred to, *N. dulcella*, has been bred at different times from wild strawberry (*Fragaria vesca*), and was referred to this species by Bankes. Cocoons that Dr. Wood sends us are somewhat similar to, but much smaller than, those of *N. fragariella*. Fletcher has bred specimens from wild strawberry that he says "may be referable to this species," but which he has "so far been inclined to consider as a small form of *N. fragariella*, considering that *N. dulcella*, in Britain at least, is a doubtful species." Meyrick writes: "British records of *N. dulcella*, Hein., seem to have been erroneously founded on specimens of this species (*N. fragariella*)." Unfortunately, Meyrick's remarks about other rare or little-known species, makes one inclined to reject this statement, unaccompanied as it is by any indication of the evidence on which the opinion is based. Wood writes: "The cocoons of *N. fragariella* in your hands were found when collecting the larvæ of *N. dulcella* from wild strawberry, and were separated from them by the character of the mine. *N. dulcella* had a narrow frass-track and very slender mine; *N. fragariella*, a broad frass-track and coarser mine" (*in litt.*, June 28th, 1898). In the "Stainton" British collection at South Kensington are specimens bred by Threlfall from strawberry, at Preston.

MINE.—Like that of *N. fragariella* (Heinemann). Wood states that the mine is finer and the frass-track narrower, and writes: "The mines of the insect which I refer to *N. dulcella*, are very long and slender, with the frass collected into a central thread of less than half the diameter of the mine" (*in litt.*).

LARVA.—The larva is pale yellow, with the head scarcely, if at all, darker (Wood).

COCOON.—The cocoons (3) average 2·1 mm. in length, and 1·9 mm. in width, so that they form an oval that approaches to the circular in outline. In colour they incline to orange-yellow (deeper in tint and much smaller than two cocoons of *N. fragariella*, that are by their side), with a few fine reticulations of a darker tint. The surface is smooth, and the texture so delicate, that the cocoons have collapsed, even one from which the pupa is still projecting. There are only a few loose strands of flossy silk attached to the outer edge. [Described June 15th, 1898, under a two-thirds lens, from cocoons sent by Dr. Wood.] Wood says: "The chief peculiarity in the cocoons of *N. dulcella* seems to me to be their rounded form, the outline being almost circular."

Pupa.—The pupa-skin projects for some distance from the cocoon; it is perfectly transparent, with some grey linear markings along the edges of the thoracic segments. The thoracic segments seem disproportionately large for the size of the pupa, the mesothorax especially so.

Food-plant.—*Fragaria vesca* (Heinemann).

Time of appearance.—Imagines, in confinement, appeared in March, from mines of the preceding autumn (Heinemann).

Localities.—Hereford: Tarrington (Wood). Lancashire: Preston (Threlfall *teste* Stainton). ? Sussex: Worthing (Fletcher).

Distribution.—Brunswick (Heinemann).

NEPTICULA GEI, Wocke (? var. *N. fragariella*).

Synonymy.—Species: *Gei*, Wocke, "Cat.," p. 336 (1871); Eppelshm., "Stett. Ent. Zeit.," li., pp. 229-235 (1890). ? *Fragariella* (*teste*, Wocke and Eppelsheim).

Original description.—*Fragariellae* similis. Alis ant. dimidia parte basali nitidissimis aureis, ceterum fuscis parum violaceo suffusis, fascia parum obliqua postmedium argentea vel pallida aurea nitidissima, capillis ferrugineis, conchulis parvis flavescentibus. Exp. al. ant. $4\frac{3}{4}$ mm. Larva bis quotannis in foliis *Gei rivalis*" (Wocke, *Catalog*, etc., p. 336).

Imago.—Head variable, orange in ♂, orange-fuscous in ♀; base of antennæ whitish, apex of antennæ ringed with white. Anterior wings 6 mm.; basal third brilliant bronzy-purplish, especially on costa; outer two-thirds violet-purple; a bright metallic golden band, widest along inner margin, passes through purple area; extreme apex somewhat bluish; cilia dark grey, blackish at apex. Posterior wings pale grey, shiny; cilia at base of inner margin, pale grey, on upper margin and round the apex darker. Thorax bronzy-purple; abdomen bronzy-green. [Described June 20th, 1898, from imagines bred from Sussex larvæ, feeding in *Geum*.]

Variation.—Ab. *semicolorella*, Epp., *Stett. Ent. Zeit.*, lii., p. 351.—Alis ant. in primis $\frac{2}{5}$ rufo-aureis, in ultimis $\frac{3}{5}$ violaceis, fascia argentea deficiente, conchulis minimis nigris. This aberration is so striking, that it deserves a distinct name. The pale silvery-golden band is entirely wanting, and there is no indication even of it, its place being occupied by the same colour as the outer part of the wing, so that the basal two-fifths is unicolorous reddish-golden, the outer three-fifths unicolorous dark violet-purple, the insect, therefore, having an altogether unfamiliar appearance, and one would probably have described it as a distinct species had it been caught. The eye-caps are exceedingly small, and black in colour; the head-hairs also black. There appear to be no other differences from typical *N. gei*. Two exactly similar females of this form were bred in February of this year, with a number of normally coloured and marked *N. gei*, from the autumn mines of *Geum urbanum*, so that its specific identity is placed beyond doubt.

Egg.—The egg appears to be usually laid on the upperside, but sometimes also on the underside, of a leaf of *Geum urbanum*. It is of the usual oval shape for this genus, length : breadth : : about 3 : 2, and about 1·6 mm. in length. The shell is quite transparent, slightly iridescent, and almost filled with the black frass of the young larva. There appears to be no definite choice exercised as to the position of the egg, which is placed sometimes on the surface quite in the centre of the leaf and away from any of the larger veins, at other times against one, whilst on other occasions it is placed quite on the margin.

Mine.—The mine, which looks like a fine, whitish, wavy, much twisted line on the upper side of a leaf of *Geum urbanum*, gradually broadening as it advances, is quite invisible on the underside. It measures probably, with the various convolutions, from 5 to 6 inches, often doubles back on itself, and crosses and re-crosses the earlier part of its path. It begins as a fine, slender, hair-like line, but at its termination a good mine is 2 mm. wide. There are no sudden expansions of the mine, at points corresponding with a larval moult, as one finds normally in certain species, and there is only one very distinct change in the arrangement of the frass. The mine itself gradually and regularly broadens with the growth of the larva, and the frass forms a slender broken line, running through the centre of the gallery, with a distinct margin on either side of the frass-line, the margin very broad in comparison with the width of the frass-line, until almost one-third of the gallery has been formed, when, although its regularity is maintained, the frass resolves itself into distinct pellets, arranged in a most orderly manner, and the distinct margin is maintained until the termination of the mine. The quantity of frass is very small, compared with that in the mines of some species, and considering the size of the mine. Under a lens the upper epidermal surface is seen to be raised or blistered, and the edge of the mine tinged with reddish, the presence of the larva having evidently discoloured the chlorophyll on the edge of the mine. Eppelsheim notes that in some mines of *N. gei*, the frass is more densely grouped and the margins more free in some than in others. Certain mines in leaves of *Rubus corylifolius* referred by Fletcher to this species, exhibit considerable difference from the mines of *N. gei*. They have a strong tendency to run by the side of a rib as long as possible, and to go from one rib to another; they also are, as a rule, broader, and the frass in the first part forms a continuous fine line, which alters, evidently after a larval moult, into a much more diffuse arrangement of the frass pellets, which are very regularly arranged individually, and form a very broad band along the centre of the gallery; in the last three quarters of an inch of the mine the frass is scattered somewhat irregularly. These differences may readily be seen with the naked eye; nor is there in any degree so clear a margin on either side of the frass-line in the mines in the leaves of *Geum*, as in the mines in the leaves of *Rubus*.

Length of larval life.—Eppelsheim notes that on Nov. 6th, 1888, he found a large radical leaf of *Geum* containing 14 mines, of which 11 were still occupied by feeding larvæ on the 21st, and the last two did not leave their mines till the 29th, so that these occupied at least 23 days in coming to maturity. On Dec. 1st, 1888, he obtained 6 other mines containing feeding larvæ, of which the latest vacated its mine on the 15th. On Oct. 26th, 1889, a leaf containing 3 larvæ was found; one of these vacated its mine next day; the others were, however, very young. One of these remained motionless, in its mine, and without feeding, until Nov. 3rd. It then fed until Nov. 10th, when it stopped again until Nov. 19th, on which date it commenced again to feed. Probably these cessations marked the moultings of the larva. The larvæ of *N. gei* leave the mine as soon as full fed, unless the leaves have been wetted, when they remain for a time; direct exposure to sun or cold, however, at once causes the larva to quit the leaf. With regard to the long moulting period, it would appear that the necessity to moult comes on suddenly, larvæ having been noticed to perform the operation when the body was bent sharply in an angle of the mine. The late appearance of the larva of *N. gei*, and the possible ill-effects of early frost, led Eppelsheim to experiment as to the possibility of its going over the winter in that stage, and to feed up in spring, as does the allied *N. pretiosa*. Accordingly, he obtained two larvæ of the latter from Hoffmann, early in April, 1889, and found both larvæ and mine similar to those of *N. gei*, and was surprised when from these there emerged, on May 19th, a *N. gei*, and on May 22nd, a *N. pretiosa*. Stainton bred specimens from *Geum urbanum*, on July 26th, 1852, from Lewisham, and on July 28th-29th, 1854, from Mickleham.

Cocoon.—The cocoons examined average 3 mm. in length, and 2·1 mm. in width. Each is roughly oval in outline, slightly thinned out on the margin, and rather wider at one end than the other. It is domed centrally, the highest point rather towards the wider end, from which the empty pupa-case projects. The colour of the silk is greenish-ochreous (with a distinct greenish tinge to the naked eye), and somewhat reticulated with darker markings. The surface is comparatively smooth, but there are some strands of flossy silk scattered over the surface, and a more plentiful supply on the outer edge. The empty pupa-case is somewhat transparent, less delicate, however, than that of many species, and with sundry delicate greenish-grey patches scattered over the thoracic segments. [Described under a two-thirds lens, June 21st, 1898, from cocoons sent by Mr. W. H. B. Fletcher.] All the cocoons are spun up in a depression on the underside of a leaf of the food-plant.

Time of appearance.—The species is double-brooded, imagines appearing in May-June and August, from larvæ found in October-November and July respectively. Fletcher says: "*N. gei* is certainly double-brooded, probably as far north as Alford in Lincolnshire, the larvæ being taken during the whole of October there." Eppelsheim notes the species as double-brooded at Heidesheim Park, Grunstädt; larvæ being obtainable throughout October and until the middle of November; the imagines appearing in May.

Food-plants.—*Geum urbanum* preferring radical leaves (Eppelsheim). *Geum rivalis* (Wocke). *Geum urbanum* and brambles, preferring deciduous forms, as *Rubus corylifolius* and *R. caesius* (Fletcher). Larvæ common on bramble at Portland (Richardson).

Localities.—Dorset: Portland and Weymouth (Richardson), Purbeck (Bankes), Bloxworth (Cambridge). Durham: Hartlepool (Bower). Kent: Chislehurst (Bower). Lincoln: nr. Alford (Fletcher). Sussex: Bramber, Arundel, Polegate, Worthing (Fletcher). Westmorland: ? Witherslack, on dewberry (Hodgkinson).

Distribution.—Northern and eastern Germany (Wocke).

Notes on N. fragariella and N. gei.

It is evident from the foregoing descriptions, etc., that the insects known as *N. fragariella* and *N. gei* must be carefully reared in numbers before the difficulties surrounding them can be cleared up. The characters of the two insects are certainly mixed up in the most marvellous manner in the references in the preceding sections, yet the British examples examined appear distinct enough as imagines, as well as in their mines and cocoons. Long series of specimens from *Fragaria*, *Agrimonia*, *Geum*, *Rubus corylifolius* and *R. caesius*, should be bred quite separately, and compared critically in every stage; only then can we pretend to know anything about them. Roughly, the comparison of bred British specimens, from *Fragaria* and *Geum* respectively, give distinct characters, but these distinctions are often quite at variance with the observations recorded by Continental authors, *e.g.*, our experience agrees absolutely with that of Eppelsheim, recorded *ante*, p. 234, so far as relates to nos. 1, 4, 5 and 6; the characters, however, are reversed in no. 2, and do not agree in the first part of no. 3. Thus:—

N. fragariella (bred by Wood) has very bright orange head in both sexes, anal segment with greyish tufts, fore-wings 4 mm. in expanse, basal area of fore-wings bright brassy, outer two-thirds of fore-wings purple-brown, the transverse fascia distinctly silvery. Cocoon bright yellow-ochreous.

N. gei (bred by Fletcher) has bright golden head in ♂, orange-fuscous (sometimes of a very dark tint) in ♀, anal segment with yellowish tufts, fore-wings 6 mm. in expanse, basal area of fore-wings golden- or bronzy-purple, outer two-thirds dark purple (almost blue-black), the transverse fascia distinctly golden. Cocoon greenish-drab.

NEPTICULA AUROMARGINELLA, Richardson.

SYNONOMY.—Species: *Auromarginella*, Rich., "Ent. Mo. Mag.," xxvi., pp. 30-31 (1890); "Proc. Dors. N. H. Soc.," xi., p. 74, fig. 10 (1891); Meyr., "Handbook," etc., p. 717 (1895).

ORIGINAL DESCRIPTION.—Exp. al. 2½-2¾ lines. Fore-wings greenish-bronze, becoming darker and more violet on the basal side of a somewhat broad, nearly straight, pale golden fascia, which crosses the wing a little beyond the middle; on the extreme hind margin is a similar narrower, crescent-shaped, pale golden fascia; the space between the fasciæ is dark violet, the whole of the wing being beautifully metallic. Hind-wings and fringes grey, with a bronzy gloss. Head ferruginous; eye-caps cream-coloured or pale ochreous; thorax like the basal half of the fore-wing; antennæ, body and legs darker, the legs with light rings (Richardson, *Ent. Mo. Mag.*, vol. xxvi., p. 31).

IMAGO.—Head ferruginous. Anterior wings 5-6 mm.; greenish-bronze, tinged with violet basally; a broad, nearly straight, pale golden fascia beyond the middle; a second, narrow pale golden fascia on the hind margin. Posterior wings and fringes bronzy-grey.

COMPARISON OF N. AUROMARGINELLA WITH N. AURELLA.—The imagines of *N. auromarginella*, though somewhat resembling those of *N. aurella*, have, besides the usual golden fascia, a second one of the same colour, situated on the hind-margin of the fore-wing. They are also smaller, and their basal portion is not brown, as in *N. aurella*, but rather bronze-green (Richardson). The *Nepticula* from the bramble, with a gold line on the hind-margin, is quite new to me. I have seen many *N. aurella*, both British and German, but I never saw anything like these (Stainton).

LARVA.—Not differentiated from that of *N. aurella*, or other bramble species.

FOOD-PLANT.—*Rubus fruticosus.*

TIME OF APPEARANCE.—Larvæ collected on October 22nd, 1888, produced imagines from November 24th-December 19th, 1888, others emerged February 12th, 1889, and seven during May, 1889.

LOCALITIES.—DORSET: nr. Weymouth (Richardson).

DISTRIBUTION.—France: Vannes (*Rubus* excl. July 2nd, de Joannis, *teste* Walsingham).

NEPTICULA SPLENDIDISSIMELLA, Herrich-Schäffer.

SYNONYMY.—Species: *Splendidissimella*, H.-Sch., “Sys. Bear.,” v., p. 353 (1855); Staud. and Wocke, “Cat.,” p. 336 (1871); Nolcken, “Lep. Fauna Est.,” p. 769 (1871); “Sand, “Cat. Lep. Auvergne,” p. 200 (1879); Snellen, “De Vlinders,” etc., p. 984 (1882); Sorhagen, “Die Kleinschmett. Brandbg.,” p. 308 (1886); Hering, “Stett. Ent. Zeit.,” lii., p. 220 (1891); Walsm., “Ent. Mo. Mag.,” xxvii., p. 152 (1891); Meyrick, “Handbook,” etc, p. 717 (1895). *Splendidissima*, Frey, “Die Tineen,” etc., p. 393 (1856); “Linn. Ent.,” xi., p. 439 (1857).

ORIGINAL DESCRIPTION.—*Nepticula splendidissimella*, Frey.—Mas purpureo-fuscus, fœmina olivaceo-æнea. Mittelgross, die Vorderflügel am Wurzelsechstheil licht messinggelb, ausserdem beim Manne purpurbraun, bein Weibe olivengrünlich, die Binde hinter der Mitte, ziemlich breit und vertikal, silbern, beim Manne etwas goldig. Um *Rubus caesius* und *R. idaeus* (Herrich-Schäffer, *Sys. Bearbeitung der Schmett. von Europa*, p. 353). As Herrich-Schäffer possibly named the species from specimens sent to him by Frey, and, in fact, adopted the MS. name of the latter, it may be well to add Frey's diagnosis. This reads as follows: “*N. splendidissima.* Capillis atris, antennarum conchula alba; alis anter. nitidissimis, violaceo-cupreis, ad basim squamis orichalceis tectis, fascia pone medium recta, ♂ dilute aurea, latiuscula (♀ argentea, tenui) apice violaceo-tincto, ciliis saturate griseis. $2\frac{3}{4}$–$2\frac{1}{3}'''$.” He also adds: “Die Grösse des Männchens ist die einer ansehnlicheren *N. anomalella*, des Weibchens einer mässigen *ruficapitella*; die Flügel nicht schmal. Gesicht und der breite Schopf tief sammetschwarz; Augendeckel gross, glänzend und weiss; Fühler schwarz. Palpen heller grau. Rücken und Schulterdecken schwärzlich, mit einzelnen glänzenden Messingschüppchen untermischt und darum für das unbewaffnete Auge bronzeartig glänzend. Hinterleib schwärzlich, Beine schwärzlich grau. Die Vorderflügel haben sehr starken Glanz, beim Manne lebhafter als beim Weibe; ihr Kolorit ist eine tiefe, ins Violette schimmernde Kupferfarbe. Die Flügelwurzel oder—richtiger gesagt—fast die Innenhälfte des Flügels bis in die Nähe der Binde, ist durch reichlich aufgelagerte helle Schüppchen lebhaft messingglänzend; ja sie kann bei einzelnen Stücken ganz messingartig erscheinen. Die Binde, entweder blass golden (♂) oder silbern (♀), ist sehr stark glänzend. Sie steht ziemlich senkrecht; ist beim ♀ mässig schmal, beim ♂ ansehnlich breiter. Nach innen ist sie schärfer abgesetzt als auswärts, wo sie mehr in die Flügelspitze verläuft. Diese selbst ist sehr dunkel violett und lebhaft glänzend; die Franzen tief grau. Ebenso verhalten sich die Hinterflügel und deren Franzen” (*Die Tineen*, etc., pp. 393-394). Fletcher writes: “Frey's short Latin diagnosis is very good. The words ‘ad basim squamis orichalceis tectis,’ hit off the distinction which separates this species from all other species of *Nepticula*. The black head, of course, also divides it from *N. aurella*, which is a larger insect” (*in litt.*).

Imago.—Head black. Anterior wings 4-5 mm.; shiny, purplish-coppery in tint, covered with brassy scales at the base; straight pale golden fascia beyond the middle of the wing; apex tinged with violet; cilia dark grey. Posterior wings and cilia also dark grey.

Comparison of N. splendidissimella with N. gei and N. aurella.—I would suggest that *N. splendidissimella* may be known from its allies by the brassy base to the forewings, as well as by the colour of the head; *N. aurella*, by the head being of the same colour in both sexes; *N. gei*, by the head being darker in the female than in the male; possibly, too, the latter has narrower fore-wings than *N. aurella* (Fletcher).

Egg-laying.—The egg appears to be laid on the under-surface of a leaf, well away from the margin, but not necessarily near a rib. The egg is oval in outline, the shell perfectly transparent, and packed almost full of black frass.

Mine.—The first part of the mine (about one-half of an inch in length) is little twisted, exceedingly fine, and practically invisible to the naked eye; in this the frass forms a broken central thread, with a distinct margin on either side. The second part of the mine widens considerably at its commencement (probably after a larval moult), and continues to do so gradually until its termination; it is about one inch long, and rather more tortuous than the first part. In this part of the mine, also, the frass is spread more than in the first part, but is still broken, and there is a much wider margin on either side. The third part of the mine is simply an extension of the second part, usually about three quarters of an inch long, and gradually widening, until, at its termination, it ends in a largish blotch, about 7 mm. by 5 mm. In the third part of the mine the frass is again more collected centrally, still, however, forming a broken line. In the final blotch it is arranged around the lower margin, the remaining area being free. The boundaries of the mine are sometimes much governed by the veins of the leaf, the mines often remaining for a considerable distance quite straight by the side of one. The larva escapes from the leaf by an aperture made in the lower epidermis. The foregoing description was made from mines in leaves of *Rubus chamaemorus*, from Rannoch. Others, in leaves of *Rubus* ? sp., from Mablethorpe, are very conspicuous, each usually commencing on or near the margin of the leaf, and being much influenced in its direction by the ribs of the leaf, the frass much broken into granules in the second and third parts of the mine, and the margin of the mine marked by a distinct change in the chlorophyll, which becomes red in contact with the mine; the egg is, however, still laid upon the undersurface of a leaf. [We are indebted to Mr. Fletcher for the mines described.] Frey writes: "Die Mine ist sehr lang und stark geschlängelt. Sie beginnt überaus fein mit ganz schlanker Kothlinie, so dass die Ränder frei bleiben, erweitert sich dann beträchtlicher, eine einfache feine Kothreihe in der Mitte führend. Ungewöhnlich breit erscheint sie später, nachdem die Raupe sie verlassen hat, an dem Blatt der Brombeere als ganz weisser Gang. Ich habe sie noch Anfangs November einzeln bewohnt gefunden" (*Die Tineen*, etc., p. 394). Threlfall notes it as "a more slender and tortuous mine than that of *N. aurella*." Nolcken writes: "The mines from which I breed *N. splendidissimella* (named by Stainton, etc.), are different from that in bramble-leaves, as described by Frey. The examination of a large number of mines shows that each is unusually long, spread over a considerable distance without any closely compressed windings, very narrow, only just wide enough for the body of the larva to pass through. This necessitates also the formation of a fine central frass-line throughout the whole course of the mine. Sometimes this shows a granulated condition, at others the frass forms a continuous thin black thread, dependent on the consistency of the excrement, which is sometimes sufficiently fluid to spread to the margins of the gallery."

Larva.—Frey describes the larva as being "about 2‴ in length, bright yellow, with dark intestinal canal showing through the skin, and pale brown head."

Cocoon.—Frey also describes the cocoon as somewhat flattened and shiny, rounded in outline and greenish.

Food-plants. — Most plentiful on *Rubus caesius*, but occurring sparingly on *R. fruticosus*, *R. idaeus* and *Rubus corylifolius* (Frey). *R. chamaemorus* (Bankes). Hodgkinson reports the breeding of a *Nepticula*, ? *splendidissimella*, in April, 1887, from dewberry (*Rubus caesius*), from larvæ obtained at Southport, October, 1886, and says: "My experience of *N. splendidissimella* coincides with that of the late John Sang, *viz.*, that it is strictly a raspberry feeder, and single-brooded."

Time of appearance.—The species is probably double-brooded as far north as Lincolnshire. There are specimens in Stainton's collection, taken April 2nd, 1857, on palings, at West Wickham, and others bred by Healy, January 29th, 1861. Fletcher never remembers having taken the larvæ before October, and then often late in the month. Richardson bred a specimen on March 13th, 1896, from a larva collected at Portland, in September, 1895. Threlfall found larvæ on July 21st, 1876, at Grange. Sang found mines at Darlington on October 13th, 1878. Sand notes it as a mountain species in Auvergne, appearing in July, the larvæ feeding on raspberry and brambles. Walsingham notes larvæ in March, 1890, from which imagines appeared the next month at Beaulieu. Threlfall bred it in June, 1880, from larvæ obtained on September 30th, 1879, at Lytham.

Localities.—Aberdeen: Braemar (Salvage *teste* Mason). Derby: Repton (Mason), Burton (Sang). Dorset: Portland (Richardson). Durham: Darlington (Sang). Kent: (Meyrick). Lancashire: Lytham, Arnside and Grange (Threlfall), Southport (Hodgkinson). Lincolnshire: Sandhills nr. Mablethorpe, nr. Alford (Fletcher). Perthshire: Rannoch (Bankes). Sussex: Goring, Arundel and Polegate (Fletcher). Westmorland: Windermere, Witherslack (Hodgkinson).

Distribution.—France: Nohaut, Indre, Mont Dore, Auvergne (Sand), Beaulieu (Walsingham). Germany: Frankfort-on-the-Main (Frey), nr. Heidelberg (Heyden), Berlin, Jungfernheide, Friedland, Hamburg, Halle (Sorhagen), Brunswick (Heinemann), Sandsee, Alt Damm (Hering). Switzerland: nr. Zürich (Frey). Russia: Pichtendahl (Nolcken). Netherlands: Friesland and Drenthe, and in most of the other provinces (Snellen).

NEPTICULA SERELLA, Stainton.

Synonymy.—Species: *Serella*, Sta., "Ent. Mo. Mag.," xxiv., p. 260 (1888). *Tormentillella*, Bankes (*nec* H.-S.), "Ent. Mo. Mag.," xxiv., p. 160 (1887). *Filipendulae* (in part), Meyrick, "Handbook," etc., p. 718 (1895).

Original description.—Exp. al. 2 lines. Head dull dark ferruginous, with a still darker central spot. Anterior wings with the basal portion of an uniform glossy golden-brown; beyond the middle is a nearly straight, moderately broad, pale golden fascia; the apical portion of the wing very dark purple, almost black, with the cilia (which have no dividing line) slightly paler (Stainton, *Ent. Mo. Mag.*, xxiv., p. 260).

IMAGO.—Head dull ferruginous. Anterior wings 4 mm.; golden-brown in colour; a nearly straight transverse pale golden fascia beyond the centre; apex dark purplish; cilia dark grey. Posterior wings and cilia grey.

COMPARISON OF N. SERELLA WITH N. TORMENTILLELLA.—The Continental *N. tormentillella*, of which I have several bred specimens, has narrower anterior wings, with the basal portion bronzy-green, and a purple band before the metallic fascia, which is rather silvery than pale golden, the apical portion of the wing purple, but not nearly as dark as in *N. serella*; head black (Stainton).

MINE.—The larva apparently begins to feed at the base of a leaflet, and gradually works right round it until the whole leaflet is completely hollowed out and transparent, and the wanderings of the larva can only be traced by the lines of dark frass which mark its course (Bankes). Threlfall notes the mine as being "clear and white."

LARVA.—The larva is of a deep clear yellow, with the posterior portion of the dorsal vessel showing through as a darker line, and the head shining brown (Bankes). Sang says that the larva is much like that of *N. poterii*.

COCOON.—The cocoons (3) measured average 2·5 mm. in length, and 1·75 mm. in width, each forms a long oval in outline, with one end considerably narrower than the other. In colour, they are, to the naked eye, what Sang calls very pale "drab." Under the lens they are pale yellow-ochreous, one with, the others without, a defined rim, the arched portion of the cocoon rising directly from the edge to the apex, which is very considerably raised above the general level. The cocoon proper is rather rough, flossy silken ends sticking out all over the surface, but much more abundantly round the somewhat crenate rim. There is a very faint reddish reticulation traceable on the domed portion, the lines exceedingly fine and faint in hue. [Described July 5th, 1898, under a two-thirds lens, from cocoons sent by Mr. W. H. B. Fletcher, from *Potentilla*, as probably of this species.]

FOOD-PLANT.—*Potentilla tormentilla*, growing on moors (Bankes).

TIME OF APPEARANCE.—Stainton found mines at Dunkeld, on September 11th, 1859, and bred an imago in July, 1860. Threlfall bred imagines in May, 1887, from larvæ obtained October 3rd, 1886, at Meathop, nr. Grange.

LOCALITIES.—? DEVON: between Barnstaple and Bideford (Stainton). ? KENT: West Wickham (Stainton). LANCASHIRE: on mosses, Meathop, nr. Grange (Threlfall). NORFOLK: King's Lynn (Atmore). NORTHUMBERLAND: Newcastle-on-Tyne (Sang). PERTHSHIRE: Birnham Hill, nr. Dunkeld (Stainton). ? SUSSEX: nr. Hayward's Heath (Fletcher). WESTMORLAND: moors (Bankes). YORKSHIRE: moors of West Riding (Bankes).

DISTRIBUTION.—? Germany: Ratisbon (Hoffmann).

NEPTICULA TENGSTRÖMI, Nolcken.

SYNONYMY.—Species: *Tengströmi*, Nolck., "Lep. Fauna von Estland," ii., no. 879, p. 776 (1871); Stdgr. and Wocke, "Cat.," p. 338 (1871); Erschoff, "Trudy Ross. Ent. Soc.," xii., p. 22 (1881).

ORIGINAL DESCRIPTION. — *Nepticula tengströmi*, n. sp. Kopfhaar rostbräunlich gelb, im Gesicht (und beim ♀) gelblicher, Nackenschöpfe schwärzlich braun; Fühler bräunlich, gelblich schimmernd; Augendeckel klein, weisslich, kaum gelblich schimmernd; Vorderflügel blass, etwas grünlich gelb messingglänzend mit schwach purpurbräunlichem Schimmer (beim ♀ stärker), die Spitze purpurbraun (beim ♀ violettblau gemischt); die sehr breite verticale Binde sehr weit nach aussen gerückt, weisslich gelb, stark metallglänzend. Leib, Beine und Unterseite ganz ohne gelblichen Schimmer, nur mit braungrau weisslichem. Flügellänge 2-2·2 mm. 6 ♂♂, 2 ♀♀. Raupe in *Rubus chamaemorus*, blass gelb, ihr Kopf fast wasserhell, blass bräunlich mit dunkler braunen Nähten und Gebiss, Keulenflecke klein, grau; Bauch mit mandelförmigen, nach hinten kleineren, bräunlich grauen Rautenflecken. Ei ober- oder unterseitig; Mine erst fadenförmig in gedehnten Windungen, dann plötzlich grosse, von kleinen, nach aussen convexen Kreisbögen begrenzte Makel; Klappe oberseitig; Koth zuerst als feiner, oft unterbrochener Faden, hierauf in Klümpchen und dann, beim Eintritt in die Makel, in Körner zerfallend, die zuerst in der Gangrichtung, dann zerstreut liegen (Nolcken, *Lep. Fauna von Estland*, pp. 776-777).

IMAGO.—Head yellowish. Anterior wings 5 mm.; pale greenish-yellow, with a faint purplish-brown gloss; the apex purplish-brown; a broad vertical transverse pale golden band beyond the middle. Posterior wings and fringes very pale brownish-grey, with a whitish silky gloss.

N. TENGSTRÖMI AS A BRITISH SPECIES.—There is only one British specimen extant of this species. The specimen was bred by Sang, from *Rubus chamaemorus*, who, it is believed, received the mines from Carrington, whilst the latter was collecting in Scotland. The specimen is now in the collection of Dr. Mason, of Burton-on-Trent, who writes: "I have been comparing my specimen of *N. tengströmi* with Continental specimens of that species, and with Nolcken's description. As far as I can make out, it is that species. It is, however, a male, and the male is much less characteristic than the female" (*in litt.*, June 6th, 1898). Carrington writes: "I have delayed answering your enquiry about *Nepticula tengströmi* until I could refer to my notes taken during my visits to Scotland, in 1874 and 1875. I do not find any special notice that would help me to exactly remember the circumstance. I well recollect gathering leaves of *Rubus chamaemorus* with *Nepticula* mines in them, and sending them to several lepidopterists to rear the moths; probably Mr. Sang was among the recipients. Most of the mined leaves were gathered on hills south of Loch Rannoch, though I may have sent some from Bræmar, but the latter locality is least likely" (*in litt.*, June 2nd, 1898). Meyrick writes (*Handbook*, etc., p. 718): "Supposed British specimens of *N. tengströmi*, Nolck., would seem to have been dwarfed examples of *N. aurella*." We have no suspicion upon what data this remark is based, nor have we ever heard of any "supposed British specimens" other than the one in Dr. Mason's collection. [Threlfall has since informed us that he bred specimens of a Nepticulid in April, 1881, from larvæ collected at Bræmar, August 15th, 1880, but he is very doubtful whether they are referable to this species.]

COMPARISON OF N. TENGSTRÖMI WITH ALLIED SPECIES.—This species belongs to Heinemann's group 7, and comes nearest to *N. plagicolella*, *N. ignobilella*, *N. distinguenda* and *N. glutinosae*, but differs from them in its narrow band. It appears to come nearest to *N. poterii* in its band, but the latter appears to be a somewhat smaller insect, the band more golden and situated not quite so far beyond the middle. In *N. poterii*, too, the basal part of the fore-wings, as far as the band, is much darker, with a purple-violet gloss, and the apex decidedly bluish, a character which does not occur at all in the ♂ *N. tengströmi*, and in the ♀ only slightly (Nolcken).

Egg-laying.—The eggs are laid on either the upper- or underside of a leaf of *Rubus chamaemorus* (Nolcken).

Larva.—The larva is pale-yellow in colour; the head almost as transparent as water, pale brownish, with darker brown sutures and mouth-parts; the venter marked with a series of almond-shaped, brownish-grey lozenges, smaller posteriorly (Nolcken).

Mine.—The mine is at first fine, thread-like and much contorted, then suddenly changes into a large blotch, bounded by small, exteriorly convex, arcs of a circle; the frass at first forms a fine, often interrupted line, it is then arranged in little heaps, finally, on entering the blotch, separating into grains, which at first lie in the direction of the mine, but afterwards become scattered; the larva escapes at the upper surface of the leaf (Nolcken).

Cocoon.—When fresh spun this is of a leather-yellow colour, a tint that is maintained afterwards (Nolcken).

Food-plant.—*Rubus chamaemorus* (Wocke).

Time of appearance.—Nolcken found larvæ on August 27th, 1867, on Tursa Moor, where, with numerous larvæ of *N. rubivora*, they live on *Rubus chamaemorus*, often both species in one leaf, although *N. tengströmi* is much rarer than *N. rubivora*. In 1866, the larvæ had all left the mines by September 7th, and in 1867, by September 5th, so that evidently the middle of August is the proper time for the larvæ. [Threlfall has specimens bred in April, 1881, from larvæ sent from Bræmar, on August 15th, 1880, which he doubtfully refers to this species.]

Localities.—? Perthshire: Hills south of Loch Rannoch (Carrington).

Distribution.—? Norway: Bossekop (Wocke); Russia: St. Petersburg (Erschoff), Livonia, Tursa Moor (Nolcken).

NEPTICULA POTERII, Stainton.

Synonymy.—Species: *Poterii*, Sta., "Ent. Weekly Int.," ii., p. 116 (July 11th, 1857); "Ent. Ann.," 1858 (pubd. December 19th, 1857. *teste*, "Ent. W. Int.," iii., p. 95), p. 96; "Man.," ii., p. 435 (1859); "Nat. Hist. Tin.," vii., p. 242, pl. xi., fig. 3 (1862); H.-Schäffer, "Sys. Bearb.," v., p. 350 (1855); Hein., "Wien. Ent. Monats.," vi., p. 304 (1862); Hein. and Sta., "Zool.," 1863, p. 8371; Frey, "Linn. Ent.," xi., p. 414 (1857); Staud. and Wocke, "Cat.," p. 337 (1871); Meyrick, "Handbook," etc., p. 718 (1895).

Original description.—*Nepticula poterii*.—Having bred the *Nepticula* from *Poterium sanguisorba*, I find it is a new species, with brownish anterior wings (violet at the tip), with a broad pale fascia; it is somewhat intermediate between *N. plagicolella* and *N. microtheriella*. I propose for it the above name (Stainton, *Ent. Weekly Intelligencer*, vol. ii., p. 116). This was followed up by a more technical diagnosis and description, as follows: "Alis anticis fusco-aureis, fascia latiuscula recta dilute aurea apicem purpureum versus; capillis ferrugineis. Exp. al. 2 lin. Head ferruginous. Antennæ dark fuscous. Abdomen and legs grey. Anterior wings pale golden-brown, with a rather broad, straight, pale golden fascia beyond the middle; apical portion of the wing violet, with violet-grey cilia. Posterior wings pale grey, with pale grey cilia (Stainton, *Entomologist's Annual*, 1858, p. 96).

Imago.—Head ferruginous. Anterior wings 4 mm. in expanse; pale golden brown in colour; a rather broad straight pale golden fascia beyond the middle; apical portion of the wing violet; cilia violet-grey. Posterior wings and cilia pale grey.

Comparison of N. poterii with N. microtheriella and N. plagicolella.—The species appears to be about intermediate between *N. microtheriella* and *N. plagicolella*. It is of about the form and size of the former, thus smaller and with narrower wings than *N. plagicolella*, but the fascia is broader and more shining than in *N. microtheriella*, though less brilliant than in *N. plagicolella*. The fascia in *N. poterii* is almost further from the base on the costa than on the inner margin; in the other two species the fascia has a tendency in the other direction (Stainton). From *N. betulicola* it may be readily distinguished by the position of the fascia, which is placed much nearer the apex in *N. betulicola* than in *N. poterii*. The fascia in *N. poterii* is intermediate in brilliancy between the fascia in *N. plagicolella* and that in *N. microtheriella*, being less brilliant than the former, yet not so dull as in the latter. In *N. poterii* the fascia is almost straight, having, if anything, a tendency to slope towards the base on the inner margin; in *N. plagicolella* and *N. microtheriella* the inclination of the fascia is in the converse direction. *N. poterii* has the anterior wings narrower than *N. plagicolella*, in that respect closely resembling *N. microtheriella*.

Egg-laying.—The egg is laid on the upperside of a leaflet of *Poterium sanguisorba*, in the example sent us for examination by Fletcher. It is placed at some distance from the margin of the leaf, is very conspicuous and silvery looking. The young larva, on hatching, at once strikes out for the margin, which it follows.

Mine.—The first part of the mine is exceedingly slender, the excrement dense and practically filling it. It winds in and out of the serrations of the leaf, and then turns back on its course, passing back parallel with its first direction, and still leaving a dense blackish frass-line. It then mines towards the centre of the leaf, leaving a wide margin on either side of the frass-track, which is spread very diffusively over the centre of the mine. The small leaf at last is converted almost entirely into a blotch, but the nature and direction of the gallery is readily followed, owing to the regularity of the frass-track, and the remnants of uneaten parenchyma that here and there edge the mine. Stainton writes: "The mine commences as a very slender gallery, passing in and out the serrations of the leaf, and nearly filled with dark grey excrement. After passing nearly round the edge of a leaf, the larva mines towards the centre, eating out the central portion of the leaf, so that the mine then appears almost a blotch."

Larva.—Length, 1½ lines. Dark amber in colour, with the dorsal vessel brownish. The head brownish-amber, the mouth and sides of the head a little darker (Stainton).

Cocoon.—The cocoon is spun on the ground, and is of a brownish-ochreous colour.

Food-plant.—*Poterium sanguisorba.*

Time of appearance.—The species appears to be double-brooded. Stainton observed that early June larvæ produced imagines in late June and early July. One date given by Stainton for the larva is June 12th, 1857, at Mickleham; he bred imagines from June 25th-July 1st, 1857, from the Mickleham larvæ.

Localities.—Dorset: Portland, common locally (Richardson). Lancashire: Arnside (Threlfall), Grange and Preston (Hodgkinson). Surrey: Mickleham (Stainton). Sussex: Worthing Downs, very local (Fletcher). Westmorland: (Hodgkinson).

Distribution.—The species is unknown on the Continent.

NEPTICULA FILIPENDULÆ, Wocke.

Synonymy.—Species: *Filipendulae*, Staud. and Wocke, "Catalog.," p. 338 (1871); Hein. and Wocke, "Schmett. Deutsch.," p. 749 (1877); Sorhagen, "Die Kleinschmett. Brandg.," p. 346 (1886); Fletcher, "Trans. Chich. and West Sussex Nat. Hist. Soc.," 1886, no. 5; Bankes, "Entom.," xxvii., p. 345; Ibid., xxix., p. 187; Meyrick, "Handbook," p. 718, in part (1895).

Original description.—Præcedenti* *(N. geminella)* valde affinis. Alis ant. aureo-brunneis versus apicem vix violaceo infusis, fascia post medium recta argentea nitida, capillis ferrugineis, conchulis flavescentibus. Exp. alar. $3\frac{1}{3}$-$3\frac{3}{4}$ mm.—Larva succinea, capite fuscescenti, in foliolis *Spireae filipendulae* marginem sequens vitam degit (Wocke, *Catalog der Lep. des Eur. Faunengebiets*, p. 338).

Imago.—Head dull ochreous. Anterior wings 4 mm.; purplish-bronzy at base; a broad, shining, silvery (or pale-golden) transverse fascia considerably beyond the centre; apex purple; cilia blackish grey, with paler tips. Posterior wings grey (sparsely covered with purple and bronzy scales in bright light); apex darker; cilia concolorous with the wings. [The colour of the transverse band is distinctly silvery in two of the specimens examined, pale golden in the others.]

Comparison of Nepticula filipendulæ with N. poterii.—Seen in series, *N. filipendulae* appears to have a brighter fascia than *N. poterii*, and when examined with a strong lens, the former is seen to have the ground colour darker, thus making a greater contrast with the fascia (Fletcher).

Egg-laying.—The egg is laid on the upperside of a leaflet, generally on the margin.

Mine.—The first part of the mine is very slender, and runs in and out the serrations of the leaflet, keeping close to the outer edge. In this part of the mine, the black frass occupies almost the whole of the gallery. The mine in its second part gets somewhat suddenly larger, the frass occupying the central area, sometimes forming a dense central thread, at others, being more diffusively spread, and a wide pale margin edging each side. The last part of the mine is similar to the second, except that it is still wider, and terminates in a small blotch, extending as far as the larva can reach, and without any frass in it. In the last part of the mine (excluding the blotch) the frass pellets are much more diffusively spread in the central line. When a leaflet is small the larva often doubles back upon its previous course, the greater part of the leaf being as it were occupied with a blotch, although even then the frass-line shows the course of the larva. The most regular blotches are found in the three terminal leaflets in which the parenchyma is continuous at the base. The mines are very conspicuous from the upper, almost invisible from the underside, until held against the light. Fletcher says: "The larva mines the leaves of the *Spiraea*, just as that of *N. poterii* mines those of *Poterium*." Sorhagen writes: "Gangmine am Blattrande entlang."

---

* It is doubtful whether Wocke's reference to the "preceding species" is not intended to refer to *N. poterii*. He marks *N. geminella* (the species preceding *N. filipendulae* in his *Catalog.*, etc.), as one of the species that he has not seen, and he could hardly describe a new species by means of its resemblance to another species which he had not seen.

Cocoon.—The cocoons (three dozen or more) average from 2-3 mm. in length, and 1·5-2 mm. in width. In outline the cocoon forms a rough oval, tending, however, to many irregular forms, owing to a very wide flange that runs round the middle line of the cocoon. This gives the cocoon a very flattened appearance, although in reality it is well arched centrally, both above and below the rim. The cocoons are dull brownish in colour, some, however, with a distinct greenish tinge. The surface of the upper part is much smoother than the lower, the former with a very strong system of reticulations, red-brown in colour, distributed over it. At the edge of the rim are a number of loose, flossy silken fibres, somewhat paler in appearance than the body of the cocoon. Many of the cocoons are spun on the upper surface of a leaf of the food-plant, others among moss, etc. [Described July 5th, 1898, under a two-thirds lens, from cocoons sent by Mr. W. H. B. Fletcher.] The cocoon is very similar to that of the *aurella* group, but with a still wider and more conspicuous lateral flange.

Food-plant.—*Spiraea filipendula*.

Time of appearance.—The insect is, no doubt, double-brooded. The larva feeds in October, and probably in July (Fletcher). Sorhagen says that the larva is to be obtained in July and October. Stainton has imagines bred in May, 1884, from larvæ obtained on Worthing Downs the preceding September.

Localities.—Sussex: Steyning Downs, Brighton Downs, Eastbourne, Worthing, not uncommon (Fletcher).

Distribution.—Germany: Silesia (Wocke), Breslau (Sorhagen).

NEPTICULA ACETOSÆ, Stainton.

Synonymy.—Species: *Acetosae* (Shield, "Zool.," 1853, p. 4153), Sta., "Ins. Brit.," p. 303 (1854); "Nat. Hist. Tin.," i., p. 228; pl. vi., fig. 2 (1855); "Ent. Ann.," 1855, 1st Ed., p. 59; "Man.," ii., p. 436 (1859); "Nat. Hist. Tin.," vol. vii., p. 150 (1862); Frey, "Linn. Ent.," xi., p. 422 (1857); Staud. and Wocke, "Cat.," p. 337 (1871); Hein. and Wocke, "Schmett. Deutsch., p. 750 (1877); Sorhagen, "Die Kleinschmett. Brandbg.," p. 345 (1886); Hering, "Stett. Ent. Zeit.," lii., p. 220 (1891); Meyrick, "Handbook," etc., p. 718 (1895).

Original description.[*]—The first notice of this species by name reads as follows: *Nepticula acetosae* (Stainton), n. sp., larvæ in the leaves of *Rumex acetosella*; July, October and November (Shield, *Zoologist*, 1853, p. 4153). Mr. Shield appears to have bred a single imago in August, 1853, from the July, 1853, larvæ. This is the specimen described in *Insecta Britannica*, where Stainton writes: "*Acetosae* (Sta.), Shield, *Zool.*, 1853, p. 4153. Alis anticis nitidis fuscis, pone medium violaceo-tinctis, fascia fere recta pone medium nitida alba; capillis fuscis. Exp. al. 2 lin. Head fuscous. Antennæ fuscous, basal joint whitish. Anterior wings shining fuscous, with a faint violet tinge beyond the middle; beyond the middle is a nearly straight, shining whitish fascia; cilia fuscous. Posterior wings pale grey, with pale grey cilia. Appears in May and August. The larva mines the leaves of the sorrel in autumn, and in July; the mine is very peculiar; it makes a series of concentric circles till, as though the centrifugal force at length became too great, it flies off at a tangent into an irregular tortuous gallery. It has only hitherto been met with by Mr. Shield, near Dublin, in some sorrel plants growing among furze bushes, consequently in sheltered situations. Mr. Shield has only succeeded in rearing a single specimen, which . . . . he has placed in my collection. As it is extremely hazardous to describe *Nepticulae* from single specimens, the above description of the perfect insect must be looked upon as an approximation only; from the habit of the larva, no doubt can attach to its being a distinct species (*Insecta Britannica*, p. 303). In 1855, Stainton writes: "Being better acquainted with the species, I give an improved description.' This reads as follows: "Head fuscous, sometimes with a few ochreous hairs. Antennæ dark fuscous, basal joint whitish. Anterior wings rather dull bronzy-fuscous beyond the middle, with a dull violet fascia, followed by a rather curved silvery-white fascia, which is slightly concave towards the base; the apex of the wing and cilia are dull violet-fuscous. Posterior wings pale grey, with pale grey cilia" (*Ent. Ann.*, 1855, 1st Ed., p. 55).

---

[*] The absolutely first note referring to this species appears to be by Stainton, and is without a name. He writes: "Other Nepticulids mine in numerous concentric circles, as the species in *Hypericum*, and that which Mr. Shield discovered last autumn in the sorrel [*Zoologist*, xi., p. 3954 (1853)].

Imago.—Head fuscous. Anterior wings 3-4 mm. (the smallest British moth); dull bronzy-fuscous, with a dull violet fascia beyond the middle, followed by a nearly straight silvery-white fascia, cilia fuscous. Posterior wings and cilia pale grey.

Egg-laying.—The egg is laid on the underside of a leaf of *Rumex acetosella*.

Mine.—The larva, as soon as it hatches, passes from the under to the upper side of the leaf, on which the egg was laid, mining a minute ring around the point of entrance. It then makes a gallery, consisting of a series of circles, each successive one being made larger. The three inner circles become bright red in colour, and in this part of the mine it is difficult to trace the thread of excrement. The outer rings (usually three or four) are whitish, and in these a central line of black excrement is clearly discernible. The larva then changes the circular plan of the gallery, mining irregularly about the leaf, which it finally quits for pupation. Sang says that the mines are difficult to find, and (especially when small) very difficult to distinguish from the ordinary spots and discolorations, always present on the leaves.

Larva.—The full-fed larva is 2 lines in length; pale amber-yellow in colour, shining and transparent; the dorsal vessel greenish; the head pale amber, faintly tinged with brown, and with two darker lines receding from the mouth; anal segment pale greenish (Stainton).

Cocoon.—The cocoons examined (a dozen or more) measure from about 1·25 to 1·75 mm. in length, and ·6 to ·75 mm. in width. Each is a rough oval in outline, rather wider at one end than at its nadir. There is an ill-developed ring surrounding the cocoon medially, but nowhere developing into a marked flange. It is very thin, and collapses readily, composed of white silk, that turns yellowish with age. The cocoon is moderately smooth, but with a considerable quantity of loose fibres, attaching it to the moss among which the examples examined are spun. [Described July 5th, 1898, under a two-thirds lens, from cocoons sent by Mr. W. H. B. Fletcher.] The full-fed larva descends to the ground to form its cocoon, which is very small, composed of whitish silk, and somewhat oval in shape (Stainton).

Food-plant.—*Rumex acetosella*. [It has also been recorded from dock, *Rumex acetosa*, by Wing.] A single sorrel leaf is sometimes mined by a dozen or more larvæ.

Time of appearance.—Generally recorded as double-brooded, the imagines appearing in May and August, from larvæ fed in September-November and July respectively. Sang says that the second brood is always much more abundant than the first. Shield records that the mines of the latter brood are sometimes to be found in thousands at Howth. They were found very abundantly there on July 20th, 1856. Bankes notes that the species appears to have a succession of broods, and to be always impatient to reach the perfect state, a proportion of the larvæ collected in September producing moths the same year if kept indoors, though in a cool place. Bower found mines at Portland on September 1st, 1892. Walsingham reports larvæ as specially abundant at Merton, in August, 1894. The dates of the bred specimens in Stainton's collection are as follows: July 28th, 30th, 31st, August 6th, 10th, 1854, August 6th, 1855, and August 2nd, 1856, from nr. Dublin; October 4th, 1854, from the Isle of Wight.

Localities.—Dorset: Purbeck (Digby), Portland (Bower). Dublin: Howth (Shield). Isle of Wight: between Niton and Blackgang (Wing). Norfolk: Merton, abundant (Walsingham). Sussex: Downs (chalk) near Worthing and Brighton, sandy lanes near Pulborough—local, but abundant where occurring (Fletcher).

Distribution.—Austria: Vienna (Herrich-Schäffer). France: Jura (Frey). Germany: Silesia (Wocke), Frankfort-on-the-Main (Heyden), Friedland (Hering), Breslau, Aachen (Sorhagen). Switzerland: Zürich (Frey).

NEPTICULA GRATIOSELLA, Zeller.

Synonymy.—Species: *Gratiosella*, Zeller (Fischer von Röslerstamm *in litt.*), "Linn. Entom.," iii., pp. 310-11 (1848); Sta., "Cat., p. 29 (1849); "Ins. Brit.," p. 305 (1854); "Man.," ii., p. 437 (1859); H.-Sch., "Sys. Bearb.," v., p. 352 (1855); Frey, "Die Tineen," etc., p. 390 (1856); "Linn. Ent.," xi., p. 430 (1857); Staud. and Wocke, "Cat.,' p. 337 (1871); Sand, "Cat. Lep. Auv.," p. 201 (1879); Peyerimhoff, "Cat. Lep. Als.," ii., 2nd Ed., p. 166 (1882); Snellen, "De Vlinders," etc., p. 987; Curò, "Bull. Soc. Ent. Ital.," xv., p. 109 (1883); Sorhagen, "Die Kleinschmett. Brandenbg.," p. 305 (1886); Meyrick, "Handbook," etc., p. 718 (1895). *Aurella*, H.-Sch., "Sys. Bearb.," v., fig. 833.

Original description.—There can be no doubt that the earliest recognisable description of this species is one by Fischer von Röslerstamm, published by Zeller. It reads as follows: "*Gratiosella*, mihi. Unter diesem Namen habe ich mehrere Modificationem vereinigt, welche mir, unter der Loupe betrachtet, eins zu sein schienen. Im sennueringer Wäldchen um Schlehen und *Crataegus* schwärmend zu Ende April gefangen. Nicht sehr selten. Kopfhaare schwarz, Fühler dunkelbraun: das Wurzelglied gelblichweiss beschuppt, einige dieser Schuppen lehnen sich an die Scheitel- und Stirnhaare, die Schuppen breit und lang Vorderflügel glänzend, bis zur Binde goldbraun; die Binde weiss metallisch; die Spitze hinter derselben violett. Alle Schuppen von gleicher Grosse. Die Franzen an der Spitze des Flügels sehr dicht schwarzbraun ; die im Hinterwinkel ziemlich lang, weisslichgrau. Der Hinterflügel und ihre Franzen weisslichgrau (Von dieser a. sind die 2 mir überlassenen Exemplare). Diese Art möchte am besten die *Hübnerella*. Hbn. 236, darstellen" (Zeller, *Linnaea Entomologica*, iii., pp. 310-311). The Continental authorities, on the other hand, do not accept this description, and refer to Stainton as the nomenclator of the species. His description reads as follows: *Gratiosella*, Dup., *Supp.*, 72, 4 (not 5); Mann. *in litt.*; ♂ *Aurella*. Zell., 306?—Much smaller than *aurella*. Head black: the fascia placed immediately before the violet apex. and perpendicular : basal portion of the wing entirely golden. Frequents hawthorn in April and May, flying in the sunshine like gnats" (Stainton, *Syst. Cat. of Brit. Tineidae and Pterophoridae*, p. 29). In 1854, Stainton diagnosed the species, and queried the reference to Duponchel, as follows: "*N. gratiosella*, Sta., *Cat.*, p. 29 (1849); ? Dup.—Alis anticis dilute aureo-brunneis, postice violaceis, fascia fere recta pone medium cærulescente-argentea ; capillis atris. Exp. al. 2 lin. Head and face black. Palpi whitish. Antennæ dark fuscous ; basal joint white. Anterior wings pale golden brown, with a nearly straight bluish-silvery fascia beyond the middle, the apex of the wing violet ; cilia fuscous. Posterior wings grey with paler cilia. The larva is one of the yellowish larvæ which mine the leaves of hawthorn in autumn" (*Insecta Britannica*, p. 305).

Imago.—Head black. Anterior wings 4-5 mm. : pale golden brown in colour ; an almost straight bluish-silvery fascia beyond the middle; tip of the wing violet ; cilia fuscous. Posterior wings grey, cilia paler.

Comparison of N. gratiosella with N. ignobilella.—Much confusion has existed between *N. gratiosella* and *N. ignobilella*, (owing to errors in Stainton's *Manual*), but these were cleared up by Wood (*Ent. Mo. Mag.*, xxx., p. 47). He writes: "Threlfall suggested that *N. gratiosella* and *N. ignobilella* were the sexes of one and the same species, subsequently my own experience in breeding *N. ignobilella* appeared to confirm his view. From yellow larvæ collected in the autumn, and carefully separated from the only two other yellow larvæ, *viz.*, *N. regiella* and *N. pygmaeella*, that could be found on the hawthorn (*gratiosella*, let it be remembered, was said to have a yellow larva, and to feed in the autumn), I bred a long series of the perfect insect, some with red heads and some with black, and as the former were all males and the latter females, they could clearly be nothing more than the sexes of one species, and *N. gratiosella* as a species seemed doomed. It was not, then, till the question arose as to what the green *oxyacanthella*-like larvæ, feeding in July and August, could be, and until moths were reared from them which answered accurately to the description of *N. gratiosella*, that its position was restored. The diagnosis in the *Manual*, ii., p. 437, is perfect, so far as the imago goes. It is a smaller insect than *N. ignobilella*, with the head black in both sexes, and a violet, rather than a purple hind margin, to the fore-wings. On the other hand, the larva is bright green, not yellow as there described, and instead of feeding in September and October, as stated in the *Entomologist's Companion*, is fed up and over by the end of August."

Egg-laying.—The egg is usually laid on the undersurface of the frill that edges the stalk of a hawthorn leaf (Wood).

Mine.—The gallery begins with a much contorted, very slender track, with a blackish-brown line of excrement, which does not touch the margins of the mine, and then gradually expands into a very broad and long gallery, or an elongate, irregular blotch, which sometimes overlaps and includes the original slender tracks. The broader part of the mine is yellowish, intersected by the rather slender wavy line of excrement (Frey). Wood writes: "The mine of *N. gratiosella* varies according to the position in which the egg is laid, and to some extent also according to the size and fleshiness of the leaf. The favourite spot for the egg is underneath the leafy frill edging the stalk. When laid here, the mine travels at first for a short distance down the stalk, it then turns round and proceeds in the opposite direction, till it reaches the blade; here it keeps accurately to the edge for some little way, and then makes one short turn back upon itself and ends, or, if the leaf be especially large and fleshy, the last turn is omitted. This form would be quite *sui generis*, were it not occasionally mimicked to a turn by that of *N. pygmaeella*, still, as the one larva is green and the other yellow, there is no risk of confusing the full mines; whilst the empty ones may be told from the position of the eggs. Sometimes, instead of a single turn back upon itself, two or three are made if the leaf be small and thin, yet for all that. the mine is so small that it manages to keep within the limits of the lobe. The other position for the egg is under one of the ribs. In this case the small twisting gallery keeps within a narrow compass in the middle of the leaf or in one of the lobes."

LARVA.—The head of the larva is of the palest brown, so that little more than the mouth-parts are visible in the mine. There is no trace of the cephalic ganglia. The ground-colour is green, inclining to bluish-green (not "yellow," as described by Stainton in the *Manual*), *oxyacanthella*-like. Frey noticed, in the *Linn. Ent.*, xii., p. 430, that this was not one of the "yellow" larvæ of the hawthorn.

COMPARISON OF MINE AND LARVA OF N. GRATIOSELLA WITH THOSE OF N. OXYACANTHELLA.—The eggs of both species are laid on the underside of the leaf, but whilst *N. gratiosella* prefers the stalk to a rib, *N. oxyacanthella* has a greater liking for the ribs. The mines are very similar, but that of *N. gratiosella* is smaller, the gyrations shorter and keeping close together, whereas in *N. oxyacanthella* the curves are sweeping, and pass across or round the lobes from one side of the leaf to the other, and even when the egg is laid upon the stalk, and the mine comes out along the edge as in *N. gratiosella*, it turns off sooner or later into the body of the leaf, and pursues its usual bold and wandering course. The best distinction, however, lies in the larvæ. The head of that of *N. gratiosella* is of the palest brown, so that little more than the mouth-parts are visible in the mine; that of *N. oxyacanthella* is grey or black, and is always distinct and sometimes very distinct; *N. oxyacanthella* also shows, but obscurely, the cephalic ganglia, of which there is no trace in the other. I think, too, that the ground-colour is more bluish in the larva of *N. gratiosella* than in that of *N. oxyacanthella*. . . In Herefordshire, both species are single-brooded. I never find the larva of *N. oxyacanthella* in July and August, nor that of *N. gratiosella* in September and October, and I have given the hawthorn hedges a good deal of attention (Wood). The mine is recognisable from its "grey" appearance and "brown" excrement (Threlfall).

Cocoon.—The cocoons (2) examined are about 2·1 mm. in length and 1·6 mm. in width, of a dark reddish or purplish-brown colour; oval in outline, with one end considerably wider then the other. The domed portion of the cocoon rises directly from the edge, leaving no rim except at one corner of the broader end, where there are slight traces of one. The domed portion rises to a considerable height, and is somewhat flattened at the top. The cocoon is somewhat roughened, loose silken fibres projecting all over the surface. Pieces of earth are attached to these loose fibres, showing the cocoon to be subterranean. [Described July 7th, 1898, under a two-thirds lens, from cocoons sent by Dr. Wood.] Wood notes that the cocoon is "subterranean;" Hind's statement that the cocoon is "pinkish-white," must refer to some other species, unless there is considerable variation, or a great change in the colour after it is formed.

Food-plant.—*Crataegus oxyacantha.*

Time of appearance.—The species is said to be single-brooded, the imagines appearing in May and June (Sand gives July for Mont Dore, in Auvergne, and Peyerimhoff, March and April for Alsace), the larvæ being full-fed, and having vacated the leaves by the end of August. Fologne notes the larvæ as full-fed on June 7th, 1860, at Brussels. The imagines are common at the end of May and beginning of June at King's Lynn (Atmore). Sang records mines at Darlington, on August 5th, 1861, and July 15th, 1871, as well as on September 26th, 1863, and October 12th, 1870. Stainton captured imagines May 21st, 1849, May 20th, 1850, May 22nd, 1851, June 5th, 1877, at Lewisham, May 17th-21st, 1851, at Beckenham, July 16th, 1854, *in cop.*, August 4th, 1849, at Lewisham, and August 5th, 1849, at Sanderstead. Stainton bred imagines on January 25th, 1853, March 6th-13th, 1855, at Lewisham, April 9th, 1853, at Beckenham. July 16th, 1852, Nov. 11th, 1852, and August 8th-16th, 1853, at Lewisham. These dates suggest either a very straggling single brood, or more probably a double brood for the species. Threlfall bred imagines from June 10th-20th, 1879, from larvæ collected at Preston, on September 23rd, 1878. Atmore captured imagines at King's Lynn, on April 27th, 1898.

Localities.[*]—Cambridge: Cambridge, common (Farren). Cheshire: Bowdon (Edleston). Derby: Burton (Sang). Dublin: Killister (Birchall). Durham: (Darlington (Sang). Edinburgh: Duddington (Logan). Gloucester: Bristol (Vaughan). Haddington: Luffness (Evans). Hereford: Tarrington (Wood). Kent: Lewisham and Beckenham (Stainton). Lanark: nr. Glasgow (King). Lancashire: Manchester (Stainton), Preston (Threlfall). Midlothian: Greenbank (Evans). Norfolk: Bawsey, North Runcton (Barrett), King's Lynn (Atmore). Surrey: Haslemere (Barrett). Sussex: Brighton (Vine), Arundel Park (Fletcher). Westmorland: Witherslack (Hodgkinson). Yorkshire: Scarborough (Wilkinson), ? York (Hind), Huddersfield (Inchbald).

Distribution.—Belgium: nr. Brussels (Fologne). France: Mont Dore (Sand). Germany: Frankfort-on-the-Main (Heyden), Alsace (Peyerimhoff), Berlin, Friedland, Stettin, Hamburg (Sorhagen). Italy: Lombardy and Piedmont, not rare (Curò). Netherlands: common (Snellen). Switzerland: nr. Zürich (Frey).

---

[*] So much confusion has existed between this species and *N. ignobilella*, owing to the mistake about the larva in Stainton's *Manual*, that possibly most of the records are untrustworthy. Both species are probably widely distributed.

NEPTICULA ULMIVORA, Fologne.

Synonymy.—Species: *Ulmivora*, Fologne, "Ent. Weekly Intell.," vol. viii., p. 92 (June, 1860); "Ann. Soc. Belg.," 1860, p. 112; Sta., "Ent. Weekly Intell.," ix., p. 13 (Oct. 1860); Tompkins, "Ent. Weekly Intell.," ix., p. 187 (1861); Hein., "Wien. Monats.," 1862, p. 264; Sta., "Nat. Hist. Tin.," vii., p. 150 (1862); "Ent. Ann.," 1862, p. 114; Hein. and Sta., "Zool.," xxi., p. 8364 (1863); Staud. and Wocke, "Cat.," p. 337 (1871); Nolcken, "Lep. Fauna Est.," p. 769 (1871); Hein. and Wocke, "Schmett. Deutsch.," p. 744 (1877); Snellen, "De Vlinders," etc., p. 986 (1882); Warren, "Ent. Mo. Mag.," xx., p. 188 (1884); Sorhagen, "Die Kleinschmett. Brandbg.," p. 305 (1886); Millière, "Nat. Sic.," v., p. 204 (1886); Meyrick, "Handbook," etc., p. 718 (1895).

Original description.—I bred, lately, from elm larvæ similar to those which I sent you last autumn, a species which I presume to be *N. ulmivora*. It is very brilliant, of the size of *N. marginicolella*. The basal portion of the anterior wings is bronzy till close to the silvery fascia, but with a reddish tint, as in *Bohemannia quadrimaculella*. The costa is slightly purplish, and the silvery fascia, placed far beyond the middle of the wing, expands towards the inner margin; the apex of the wing is violet. The head is black, the antennæ are whitish at the base, then black to the middle, with the tips white. The last character does not occur in *N. marginicolella*" (Fologne, *Entom. Weekly Intelligencer*, vol. viii., p. 92).

Imago.—Head black. Anterior wings narrow, 4-5 mm. in expanse; bright coppery in colour, redder towards the costa, and to a slight extent towards the silvery fascia; beyond the latter the wing is brownish-black; apex purple. The fascia beyond the middle rather oblique, broad silvery (with a slight golden tinge), and highly metallic; cilia near the apex, with pale grey tips, near the anal angle blackish. Posterior wings and cilia pale grey.

Comparison of N. ulmivora with N. gratiosella.—This species is very like *N. gratiosella*, but is distinguished by the bright coppery colour of the costa of the anterior wings, by the pale grey cilia and hind-wings, and by the whitish-grey middle tibiæ. It may also be further distinguished from the remaining black-headed species of the group, by the silvery fascia not being bordered with dark towards the base (Heinemann).

Egg-laying.—The egg is laid on the underside of a leaf, against the midrib or a lateral one.

Mine.—The mine is very different from that of *N. viscerella*. It commences as a slender track containing a linear thread of excrement, which does not occupy the whole width of the mine (Stainton). Fologne writes: "The caterpillar of this species mines the leaves of elm, like that of *N. marginicolella*, making long galleries, which are whitish when small." Frey says it "forms circular and visceriform tracks in leaves of *Ulmus campestris*."

Larva.—The larva can always be distinguished from that of *N. viscerella* by its blue-green colour (Warren). Fologne says the larva is green, like that of *N. viscerella*, but that the latter is easily distinguished by the twisted gallery it makes. Fletcher, too, states that he cannot separate the larva from that of *N. viscerella*. Wood writes: "Larva greenish-blue. Head very pale, with mouth-parts dark. Abdominal canal dark brown, cephalic ganglia and cord invisible. Legs unusually long. Ventral side directed upwards in mine" (*in litt.*). Nolcken describes the larva as "very glossy, deep green, frequently bluish-green in colour; its head almost transparent, very pale brown, with darker antennæ (?), sutures and mouth-parts. The legs are conspicuous and larger than is usual in the genus."

Comparison of the mine of N. ulmivora with those of N. marginicolella and N. viscerella.—The occupied mine can be at once told from that of *N. marginicolella*, since the larva of the latter is yellow, that of *N. ulmivora* green, but it is less easily told from that of *N. viscerella*, which also has a green larva. The mine of the latter, however, is so closely wound that scarcely any uneaten leaf-substance is left between the curves, and the mine obtains a blister-like appearance. *N. viscerella*, too, lays its egg on the upperside of a leaf, whilst that of *N. ulmivora* is laid on the underside, and although the mine of the latter is frequently strongly twisted, yet the curves are never so close as to leave no leaf-substance between them (Nolcken).

Cocoon.—The cocoons average 2·1 mm. in length and 1·3 mm. in width. The basal surface is quite flattened, the upper surface domed, springing almost directly from the edge (as there is scarcely a trace of a defined basal rim), round which, however, bunches of silken fibres stretch out at almost regular intervals, and have undoubtedly served to keep the cocoon in position; in outline the cocoon is almost a perfect oval. It is red-brown in colour, with a somewhat smooth surface, but rather plentifully surrounded by ochreous or whitish flossy silk fibres, which are especially abundant on the upper surface. [Described June 14th, 1898, under a two-thirds lens, from cocoons sent by Dr. Wood.]

Food-plant.—*Ulmus campestris.*

Time of appearance.—The species is probably double-brooded, but is later in appearing than *N. marginicolella*, and, probably, *N. viscerella*. McLachlan bred it in June, 1861, from larvæ found the preceding autumn, at West Wickham. Sang notes it on June 7th, 1868, at Darlington, and Tompkins as taken on palings near Clapham Common, on August 30th, 1860. Sang found larvæ on October 17th, 1871, August 13th, and September 16th, 1873, September 14th, 1874, at Darlington, and September 24th, 1874, at West Wickham. It is very uncertain in its appearance, some years appearing in great abundance. This happened at Cambridge in the autumn of 1882. Stainton records the capture of larvæ, three being "nude on a fence," on October 2nd, 1860, between Norwood Station and West Wickham Wood. Threlfall bred imagines in May, from larvæ obtained September 30th, 1876, at Witherslack. Nolcken found mines on September 19th, 1865, almost all unoccupied, at Umbaid, nr. Pichtendahl, and again from August 7th-11th, 1866, when only five out of eleven were occupied; on September 3rd, 1871, more were occupied, but still so many were empty that it seemed probable from the early maturity of the autumn larvæ that there is only one brood in the year.

Localities.—Cambridge: Cambridge, uncertain, sometimes abundant (Warren). Dorset: Bloxworth (Cambridge). Durham: Darlington (Sang). Hereford: Tarrington (Wood). Kent: West Wickham (McLachlan). Lancashire: Dutton (Hodgkinson), Grange (Threlfall). Norfolk: K. Lynn, in elm hedges, periodic in appearance (Atmore). Surrey: Clapham Common (Tompkins). Sussex: Bramber, in elm hedges, local (Fletcher). Westmorland: Witherslack (Threlfall).

Distribution.—Belgium: nr. Brussels (Fologne). France: St. Martin Lantosque (Millière). Germany: Frankfort-on-the-Main (Frey), Berlin, Hamburg, Brunswick, Breslau, (Sorhagen), Silesia

(Wocke). Netherlands: Rotterdam, Gravenhage (Snellen). Russia: Oesel (Sorhagen), Umbaid, nr. Pichtendahl (Nolcken).

NEPTICULA PRUNETORUM, Stainton.

SYNONYMY.—Species: *Prunetorum*,* Sta., "Ent. Ann.," 1855, 1st Ed., p. 50; "Nat. Hist. Tin.," i., p. 238, pl. vi., fig. 3 (1855); "Man.," ii., p. 437 (1859); Const., "Mem. Nat. Hist. Autun," xii., p. 354 (1866); Staud. and Wocke, "Cat.," p. 337 (1871); Hein. and Wocke, "Schmett. Deutsch.," p. 745 (1877); Sand, "Cat. Lep. Auv.," p. 201 (1879); Snellen, "De Vlinders," p. 984 (1882); Peyer., "Cat. Lep. Als.," ii., 2nd Ed., p. 166 (1882); Sorhagen, "Die Kleinschmett. Brandbg.," p. 305 (1886); Hering, "Stett. Ent. Zeit.," lii., p. 220 (1891); Meyrick, "Handbook," etc., p. 719 (1895). *Perpusillella*, H.-Sch., "Sys. Bear.," v., p. 353 (1855); Frey, "Die Tineen," etc., p. 390 (1856); "Linn. Ent.," xi., p. 432 (1857).

ORIGINAL DESCRIPTION.—Alis anticis dilute æneis, basim versus purpureo-tinctis, fascia media nigra, fascia postica argentea; capillis atris. Exp. al. 2 lin. Head and face deep black. Antennæ black, basal joint white. Anterior wings with the basal half pale bronzy, at the extreme base with a purple tinge; in the middle is a well-defined black fascia, followed by a straight, moderately broad silvery fascia; the entire apex of the wing black; cilia blackish. Posterior wings pale grey, with dark grey cilia (Stainton, *Ent. Annual*, 1855, 1st Ed., p. 50).

IMAGO.—Head deep black. Anterior wings 4-5 mm. in expanse; pale bronzy with a purple tinge at the base; a black fascia in the middle is followed by a straight, rather broad, silvery fascia; apex of the wing black; cilia blackish. Posterior wings pale grey with dark grey cilia.

COMPARISON OF N. PRUNETORUM WITH N. PLAGICOLELLA AND N. ACETOSÆ.—The species to which it is most nearly allied are *N. plagicolella* and *N. acetosae*; from the former it is distinguished by the pale bronzy basal half of the anterior wings and the black head, and from the latter it is distinguished readily by the extreme brightness of the anterior wings, by the silvery fascia being further from the apex, and bordered internally by a well-defined black fascia (Stainton).

EGG-LAYING.—The egg is laid on the underside of a sloe leaf, generally close to the midrib.

MINE.—The larva commences to make a closely contorted mine, the contortions of which are as close as in the mine of *N. viscerella*, so that it forms a brown blotch; when the larva is nearly full-fed, it deviates from this peculiarity in the form of its mine, and makes an irregular gallery; the excrement, which is at first rather pale grey. fills up nearly the whole width of the mine. When the larva is full-fed, it comes out at the upper side of the leaf (Stainton). Meyrick says: "The galleries are at first spirally coiled, afterwards extending round leaves of blackthorn and sometimes cherry." Frey writes: "Die Mine ist ein verhältnissmässig langer Gang, aber mit ganz dicht gegen einander gelagerten, spiraligen, von der Kothreihe erfüllten Windungen, so dass sie als ein kreisrunder Fleck erscheint. Nur der Endtheil geht in gerader Richtung davon ab" (*Die Tineen*, etc., p. 391).

LARVA.—Length 2 lines; unicolorous dull green, the second segment a little darker; head dull green, the mouth and two lines receding from it reddish-brown (Stainton). Frey writes: "Das Räupchen misst unter 2‴. Es hat eine grüne Körperfarbe, einen grünlichbraunen Kopf, braunrothe Mundtheile und davon ausgehend zwei gleichfarbige Linien über das Köpfchen" (*Linn. Ent.*, xi., p. 434). The larva mines with the dorsum uppermost (Wood).

---

* Herrich-Schäffer writes (*Correspondenzblatt*, 1860, p. 59):—"*N dimidiatella* ist die spätere *prunetorum*, Beschreibung und Bild immerhin noch kenntlicher als manche spätere Beschreibung anderer."

COMPARISON OF THE LARVA AND MINE OF N. PRUNETORUM WITH THOSE OF N. PLAGICOLELLA.—The larva of *N. plagicolella* is yellow, and makes a clear whitish blotch preceded by a slender gallery; that of *N. prunetorum* is green, and its mine is coiled like a watch-spring, afterwards extending round the edge of the leaf. The frass fills up the gallery, and makes it light brown (Threlfall).

COCOON.—The cocoon is pale or dark ochreous, not flossy, of rather irregular oval form; the pupa protrudes its anterior segments from the cocoon previous to the appearance of the perfect insect (Stainton). Frey says: "Der Cocon ist blass gelbroth, ganz flach und ziemlich eckig."

FOOD-PLANTS.—*Prunus spinosa*. *Prunus avium* (Frey), *P. cerasus* (Hering).

TIME OF APPEARANCE.—The species is recorded as being only single-brooded. Imagines emerged freely from June 5th-12th, 1882, from larvæ collected September 20th, 1881, at Witherslack; larvæ obtained in same locality September 2nd, 1886 (Threlfall). Peyerimhoff says that in Alsace the imago appears in April, from October larvæ.

LOCALITIES.—BUCKS: Loudwater (Boyd). CAMBRIDGE: Cambridge (Farren). CHESHIRE: Bowdon (Edleston). DORSET: Portland, abundant, Weymouth (Richardson), Bloxworth (Cambridge). HEREFORD: Tarrington (Wood). LANCASHIRE: Manchester (Stainton), Preston (Threlfall), Grange (Hodgkinson). NORFOLK: King's Lynn (Atmore). SUSSEX: Abbott's Wood, High Down, and downs near Worthing, common (Fletcher). WESTMORLAND: Witherslack (Threlfall).

DISTRIBUTION.—France: Nohaut (Sand), Saone-et-Loire (Constant). Germany: generally distributed (Heinemann and Wocke), Frankfort-on-the-Main (Heyden), Jungfernheide, Potsdam, Friedland, Hamburg (Sorhagen), Alsace (Peyerimhoff), Alt Damm, Nemitz, Misdroy (Hering). Netherlands: Overijssel, Gelderland (Snellen). Switzerland: nr. Zürich (Frey).

NEPTICULA MARGINICOLELLA, Stainton.

SYNONYMY.—Species: *Marginicolella*, Sta., "Zool.," 1853, p. 3958; "Ins. Brit.," p. 305 (1854); "Nat. Hist. Tin.," i., p. 134, pl. iii., fig. 2 (1855); "Man.," ii., p. 437 (1859); H.-Sch., "Sys. Bearb.," v., p. 351 (1855); Frey, "Die Tineen," etc., p. 394 (1856); "Linn. Ent.," xi., p. 443 (1857); Const., "Mem. His. Nat. Autun," xii., p. 354 (1866); Staud. and Wocke, "Cat.," p. 337 (1871); Nolck., "Lep. Faun. Est.," p. 770 (1871); Hein. and Wocke, "Schmett. Deutsch.," p. 742 (1877); Sand, "Cat. Lep. Auv.," p. 201 (1879); Bang-Haas, "N. H. Tids.," xiii., p. 217 (1881); Wallgrn., "Ent. Tids.," ii., p. 128 (1881); Snellen, "De Vlinders," etc., p. 985 (1882); Peyer., "Cat. Lep. Als.," ii., 2nd Ed., p. 163 (1882); Curò and Turati, "Bull. Soc. Ent. Ital.," xv., p. 108 (1883); Sorhagen, "Die Kleinschmett. Brandbg.," p. 304 (1886); Mill., "Nat. Sic.," v., p. 204 (1886); Hering, "Stett. Ent. Zeit.," lii., p. 220 (1891); Meyrick, "Handbook," etc., p. 718 (1895). *Aurella*, Haw., "Lep. Brit.," p. 584, in part (1828); Zell., "Linn. Ent.," iii., p. 306, in part (1849). ? *Lemniscella*, Zell., "Linn. Ent.," iii., p. 313 (*teste* Stainton) (1849). *Centifcliella*, Sta., "Cat.," p. 29 (1849); "Trans. Ent. Soc. Lond.," v., p. 132 (excl. Zeller's description). ? *Gratiosella*, Ghiliani, "Mem. de. Reale Accad. del. Sci. di Torino," 1852, xiv.

ORIGINAL DESCRIPTION.—The first notice of this species reads as follows: Two larvæ were distinguished on elm, the one yellow and the other green. The imago of the green one is not closely allied to any previously known species; from the gut-like appearance of its mine, Mr. Douglas has proposed for it the name of *N. viscerella*. The imago produced from the yellow larva is the *N. centifoliella* of my *Catalogue*, but clearly not the Continental *N. centifoliella*, which is a rose-feeder. From the tendency of the larva to mine at the edge of the leaf, going even in and out all the serratures of the leaf, I propose to call it *marginicolella* (Stainton, *Zoologist*, 1853, p. 3958). The earliest description of the species under this name is as follows: "*N. marginicolella*, Sta., *Zool.*, 1853, p. 3958. *Centifoliella*, Sta., *Cat.* *Aurella* var. γ, Haw. ? *Lemniscella*, Zell. Alis anticis laete aureo-brunneis, pone medium purpureo-tinctis, apice saturate purpureo, fascia obliqua pone medium argenteo-alba; capillis ♂ atris, ♀ ferrugineis. Exp. al. 2½-3 lin. Head of the male black, of the female reddish-yellow. Palpi whitish. Antennæ fuscous; basal joint whitish. Anterior wings rich golden-brown, with a purple tinge beyond the middle; beyond the middle is a rather oblique, silvery-white fascia; the apex of the wing is deep purple; cilia pale fuscous. Posterior wings grey, with grey cilia. The yellowish larva mines in autumn and in July the leaves of the elm, making a long, not intertwined, gallery, frequently at the edge of the leaf, going in and out of each serrature" (Stainton, *Insecta Britannica*, p. 305).

Imago.—Head of the male black, of the female reddish. Anterior wings 5-6 mm. in expanse; rich golden-brown in colour, tinged with purple; beyond the middle is a rather oblique silvery fascia margined towards base with deep purple; apex deep purple; cilia pale fuscous. Posterior wings blackish-grey, with grey cilia.

Sexual dimorphism.—Frey writes: "Im männlichen Geschlechte, auch wenn wir absehen von der bedeutenderen Kleinheit der Art, den ein wenig breiteren Vorderflügeln, leicht zu unterscheiden durch den schwarzen Schopf, die grösseren Augendeckel und die an dem Wurzeltheile der Hinterflügel befindlichen, den gewöhnlichen dunkelgrauen Franzen aufgelagerten, nur halb so langen schwarzen Schuppenhaare" (*Linn. Entom.*, xi., pp. 443-444).

Comparison of N. marginicolella with N. aurella, etc.—*N. marginicolella* belongs to that section of the genus in which the fascia on the anterior wings is brilliantly metallic. Among these species it is readily distinguished from all except *N. aurella*, by the deep purple colour beyond the middle of the anterior wings; from *N. aurella*, the narrower, more obliquely placed, and more silvery fascia, readily enables us to separate it, and the black head of the male alone is sufficient to distinguish that sex from the male *N. aurella*, which has, like its consort, the head reddish-yellow (Stainton). Fletcher writes: "Heinemann is quite correct in that *N. ulmivora* has not, and *N. marginicolella* has, the purple border to the silvery fascia well developed."

Egg-laying.—The egg is sometimes deposited on the upper, but more generally on the under, surface of an elm leaf.

Mine.—The mine consists of a long gallery placed under the edge of a leaf of elm. At the commencement of its mine the larva leaves only a single track of excrement, but, as soon as the width of the mine will admit, the excrement is placed in a series of grains across the mine, forming little arcs of circles; the larva almost always goes towards the edge of the leaf, and, when there, continues to keep close to the margin, going in and out of each serrature of the leaf, and thus frequently going up one side of the leaf, round the apex and down the other side; the excrement is, during the first half of the mine dark brown, but in the latter half it is nearly black. When the larva is nearly full-grown, the excrement does not fill up the whole width of the mine (Stainton). Frey writes: "Die Mine wird in eigenthümlicher Art gewöhnlich (aber doch ausnahmelos*) bald gegen den Blattrand geführt, um hier jeder Krümmung desselben zu folgen und so zum stark gezackten Gange zu werden, welcher von breiter, braunschwarzer Kothreihe gefüllt wird" (*Die Tineen*, etc., p. 395).

Larva.—Length 2 lines; pale amber-yellow; the head pale brown, and the hinder lobe of the head showing through the upper surface of the prothorax as a pale brown spot (Stainton). The larva mines with the dorsum uppermost (Wood). Nolcken describes the larva as "pale (whitish) yellow, with pale reddish-brown head, the intestinal canal brownish, and faintly visible through the skin, the venter being marked with a series of lozenge-spots."

Cocoon.—The cocoons average 3·1 mm. in length and 1·9 mm. in width. The cocoon is dark greenish-grey, sometimes tinged with brown. It forms, roughly, an oval in outline, squared towards its narrower end. The wider end is somewhat flattened on its margin, forming a considerable flange, rising rather rapidly at some distance within the border to the central domed area. The latter portion of the cocoon is rather smooth, but the flanged portion is well-supplied with flossy whitish silken fibres, by which the cocoon is attached to some object. Two of the six cocoons examined have an irregular fracture (probably not for escape of pupa) at the narrower but thicker end. The flat base suggests that it is spun on a leaf, etc. [Described June 5th, 1898, under a two-thirds lens, from cocoons sent by Dr. Wood.] Some cocoons sent by Fletcher are almost green-black in colour, and average 3·3 mm. in length, and 2·1 mm. in width. Stainton observes that the larva usually leaves the mine to spin its cocoon, and he has noticed that in those cases in which the cocoon is formed inside the mine, the imago is never bred, and hence he supposes that they only thus construct it when weak or diseased. He describes the cocoon as "dark greenish-brown in colour, the pupa protruding its anterior segments before emergence." Hind gives the colour of the cocoon as "green." Nolcken says the fresh cocoon is greenish-brown, with a paler greenish rim, sometimes blackish-green, or dirty leaf-green.

Food-plant.—*Ulmus campestris.*

Time of appearance.—The insect is double-brooded, appearing in May and again in August; the larvæ of these broods may be found in September, October and July respectively. The imago was taken on May 9th, 1847, at Beckenham (Bedell), and on April 21st, 1896, at Aberfoyle, where it was beaten out from amongst heather (Evans). Mines were found commonly on elm at Lewisham, October 8th, 1891, October 3rd, 1892 (Bower); whilst Shield obtained larvæ in elm leaves in October, 1853, at Howth. On the other hand, at Haldon, many larvæ had left the mines on September 21st. 1865 (Jordan). Stainton captured imagines May 17th, 1851, April 17th, 1853, at Lewisham;

---

*In den grossen Blättern junger Bäume kann, wie ich mehrfach sah, die Mine dicht an der Medianrippe beginnen, dann neben einer Seitenrippe nach dem Aussenrand gehen und in gestrecktem Verlaufe enden, ehe sie jenen erreicht hat.

May 28th, 1850, June 2nd, 1852, June 9th, 1848, *in cop.*, at Beckenham. In confinement, imagines emerged April 5th-17th, 1853, March 22nd-30th, April 18th-19th, 1854, at Lewisham. Nolcken notes the capture of larvæ at Umbaid on September 3rd and 8th, 1865; whilst Sorhagen gives the larvæ as occurring in July, and again in September-October, in Germany. Threlfall bred the imagines in April and May, 1888, from larvæ obtained October 1st, 1887, at Bowdon in Cheshire.

LOCALITIES.—ABERDEEN: Pitcaple, not rare (Reid). CHESHIRE: Bowdon (Threlfall). CAMBRIDGE: Cambridge (Farren). DERBY: Burton (Sang). DEVON: Haldon and Coombe Lane (Jordan). DORSET: Purbeck (Bankes), Weymouth (Richardson). DUBLIN: Clontarf (Birchall), Howth (Shield). DURHAM: Darlington (Stainton). GLOUCESTER: Bristol (Stainton). HEREFORD: Tarrington (Wood). ISLE OF WIGHT: (Stainton). KENT: West Wickham (Stainton), Beckenham (Bedell), Lewisham (Bower). LANCASHIRE: Preston, Grange (Threlfall), Manchester (Stainton). NORFOLK: North Runcton (Barrett), King's Lynn, common (Atmore). PERTH: Aberfoyle (Evans). SURREY: Mickleham (Stainton), Haslemere (Barrett). SUSSEX: Bersted, Bognor, Eastbourne, Worthing, common in hedges of elm (Fletcher), Brighton (Elisha). WESTMORLAND: Witherslack (Hodgkinson). YORKSHIRE: Doncaster (Corbett), Richmond (Sang), York (Hind).

DISTRIBUTION.—Austria: Vienna (Fischer von Rösslerstamm). Denmark: Copenhagen (Bang-Haas). France: Cannes (Millière), Saone-et-Loire (Constant), Nohaut (Sand). Germany: generally distributed (Heinemann and Wocke), Glogau (Zeller), Frankfort-on-Main (Heyden), Berlin, Potsdam, Havelland, Hamburg, Halle (Sorhagen), Alt Damm, Friedland (Hering). Italy: Piedmont (Curò), Turin (Ghiliani), ? Leghorn and Montenero (Mann, who records *aurella* from elm). Netherlands: generally distributed (Snellen). Russia: Umbaid, nr. Pichtendahl (Nolcken). Scandinavia: Scania (Wallengren). Switzerland: nr. Zürich (Frey).

NEPTICULA ALNETELLA, Stainton (*nec* Heinemann).

SYNONYMY.—Species: *Alnetella*, Sta., "Ent. Ann.," 1856, pp. 43-44; "Man.," ii., p. 437 (1859); "Nat. Hist. Tin.," vii., p. 220, pl. x., fig. 3 (1862); Frey, "Linn. Ent.," xi., p. 437 (1857); Staud. and Wocke, "Cat.," p. 337, in part (1871); Nolcken, "Lep. Fn. Est.," p. 771 (1871); Mill., "Cat. Lep. Alp. Mar.," p. 372 (1875); Hein. and Wocke, "Schmett. Deutsch.," p. 745 (1877); Sand, "Cat. Lep. Auv.," p. 201 (1879); Wallgrn., "Ent. Tids.," ii., p. 128 (1881); Bang-Haas, "N. H. Tids.," xiii., p. 217 (1881); Snellen, "De Vlinders," etc., p. 989 (1882); Peyer., "Cat. Lep. Alsace," 2nd Ed., ii., p. 164 (1882); Curò, "Bull. Soc. Ent. Ital.," xv., p. 109 (1883); Sorhagen, "Die Kleinschmett. Brandbg.," p. 305 (1886); Hering, "Stett. Ent. Zeit.," lii., p. 220 (1891); Meyrick, "Handbook," etc., p. 719 (1895); *nec* Hein., "Wien. Monats.," 1862, p. 266 [which=*rubescens*, Hein., "Berl. Ent. Zeits.," p. 214 (1871)].

ORIGINAL DESCRIPTION.—Alis anticis saturate aureo-brunneis, dorso basim versus dilute aureo-brunneo, apice nigrescente, fascia paullo post medium parum obliqua argentea splendidissima; capillis ferrugineis. Exp. al. 2-2½ lin. Head and face reddish-yellow; palpi whitish; antennæ fuscous, basal joint whitish. Anterior wings deep golden-brown, shading off to a pale golden-brown on the inner margin near the base; a little beyond the middle is a rather oblique silvery fascia, extremely brilliant (more so than in *N. marginicolella*); apical portion of the wing dark purple, almost black; cilia dark fuscous. Posterior wings grey, with grey cilia (Stainton, *Entomologist's Annual*, 1856, p. 43).

IMAGO.—Head ferruginous. Anterior wings 4-5 mm. in expanse, of a deep golden-brown colour, shading off into a pale golden-brown on the inner margin near the base; just beyond the middle is a rather oblique, slender, very brilliant, silvery fascia; tip of the wing purplish-black; cilia fuscous, with the extreme edge whitish. Posterior wings and cilia grey.

COMPARISON OF N. ALNETELLA WITH N. AURELLA AND N. MARGINICOLELLA.—*N. alnetella* may be distinguished from *N. aurella* by the absence of any indication of a purple fascia before the silvery one, and by the paler golden colour at the base of the inner margin. These two last characters also serve to distinguish it from *N. marginicolella*, which is sometimes but little larger than *N. alnetella*, and, besides, the fascia, in the latter, is also more oblique (Stainton).

EGG-LAYING.—The egg is laid on the underside of an alder leaf, close to one of the lateral ribs.

MINE.—The mine forms a long, slender gallery, very wavy and irregular, the excrement forming a central blackish line, and is similar in character throughout, except that it gradually becomes broader as the larva increases in size.

LARVA.—The full-grown larva resembles somewhat that of *N. microtheriella*. Its length is nearly 2 lines; colour pale amber-yellow, with the dorsal vessel green, anteriorly whitish; the head pale brown, with the mouth and two slender lines receding from it dark brown; the supposed renal organs showing as two brown serpentine viscera. Nolcken writes: "Die Raupe ist hellgelb, der Kopf sehr blass bräunlich, Keulenflecke klein, grau, undeutlich, meist unter den Rändern des Kopfes verborgen; sie verlässt die Mine durch die untere Blattseite."

COCOON.—The cocoons (3) average 2·5 mm. in length and 1·8 mm. in width. They are roughly almond-shaped one end being considerably narrower, the other wider and rounded on the margin. The raised surface rises regularly from the edge of the cocoon, and becomes highest at the narrow end. The pupa emerges from the broader end. The colour of the cocoon is dark red-brown, the surface rough, with the ends of silken fibres projecting roughly and irregularly all over the surface. The empty pupa-case is exceedingly transparent (more transparent than is usual, even in this group), the skin looking just like a delicate film and showing slight iridescence. [Described June 15th, 1898, under a two-thirds lens, from cocoons sent by Dr. Wood.] Stainton says: "The cocoon resembles that of *N. salicis*, and is spun up on the surface of the ground." Nolcken notes: "Cocon heller oder dunkler bräunlich ochergelb, ziemlich flach birnförmig, manchmal elliptisch."

FOOD-PLANT.—*Alnus glutinosa.*

TIME OF APPEARANCE.—Probably double-brooded. The imagines appear in May and early June from mines of the preceding September-October. Imagines are also to be obtained in July, probably from June larvæ. Bower captured imagines on July 18th, 1892, by sweeping alder trees at Eltham; whilst Stainton bred imagines April 29th, 1855, from Beckenham larvæ, May 6th, 1855, from Darlington larvæ, June 24th and July 7th, 1858, from Beckenham, June 3rd-6th, 1857, from Reigate larvæ. Threlfall bred imagines in June, from larvæ obtained at Windermere, Sept. 20th, 1880. Stainton found mines on October 15th-22nd, 1854, at Beckenham; Law, on October 18th, 1854, at Darlington; Bower, on October 19th, 1892, October 6th, 1894, September 11th, 1895, October 21st, 1897, at Eltham;

Sang, on October 12th, 1856, October 7th, 1857, October 15th, 1861, and September 29th, 1871, at Barnard Castle, September 12th, 1873, and October 14th, 1874, at Stanhope, October 14th, 1878, at Wolsingham.

LOCALITIES.—CAMBRIDGE: Chippenham (Farren). CHESHIRE: Bowdon (Edleston). DORSET: Bloxworth (Cambridge), Purbeck (Bankes), Weymouth (Richardson). DURHAM: Darlington (Law), Barnard Castle, Stanhope, Wolsingham (Sang). ESSEX: Brentwood (Elisha). GLOUCESTER: Bristol (Stainton). HEREFORD: Tarrington (Wood). KENT: Beckenham (Douglas), Eltham (Bower), Lewisham (Stainton). LANCASHIRE: nr. Manchester (Chappell), Preston (Threlfall), Grange (Hodgkinson). NORFOLK: Merton (Barrett), King's Lynn, common (Atmore). SOMERSET: Clevedon (Mason). SURREY: Reigate Heath (Stainton). SUSSEX: Tilgate Forest (Fletcher), Guestling (Bloomfield). WESTMORLAND: Windermere (Hodgkinson). YORK: Scarborough (Wilkinson), York (Stainton), Harrogate (Sang).

DISTRIBUTION.—Denmark (Bang-Haas). France: Cannes, plaine de la Roubine, bords de la Saigne, du Var, etc. (Millière), Nohaut, Indre (Sand). Germany: Ratisbon (Hoffmann), Brandenburg, Hamburg, Silesia, Saxony, Hanover (Sorhagen), Bavaria (Wocke), Alsace (Peyerimhoff), Alt Damm, Güterbahnhof (Hering). Italy: ? Nizzardo, ? Liguria (Curò and Turati). Netherlands: various localities in S. Holland and Friesland (Snellen). Russia: Pichtendahl (Nolcken). Scandinavia: Scania (Wallengren). Switzerland: Zürich (Frey).

NEPTICULA CONTINUELLA, Stainton.

SYNONYMY.—Species: *Continuella*, Sta., "Ent. Annual," 1856, p. 42; "Man.," ii., p. 457 (1859); Frey, "Linn. Ent.," xi., p. 436 (1857); Hein., "Wien. Monats.," 1862, p. 301; Hein. and Sta., "Zool.," xxi., p. 8368 (1863); Staud. and Wocke, "Cat.," p. 337 (1871); Nolcken, "Lep. Fn. Est.," p. 772 (1871); Hein. and Wocke, "Schmett. Deutsch.," p. 746 (1877); Wallgrn., "Ent. Tids.," ii., p. 128 (1881); Snellen, "De Vlinders," p. 990 (1882); Sorhagen, "Die Kleinschmett. Brandbg.," p. 345 (1886); Meyr., "Handbook," etc., p. 719 (1895).

ORIGINAL DESCRIPTION.—Alis anticis, basim versus, obscure æneo-griseis, apice saturate purpureo-fusco, fascia media saturate purpurea, fascia pone medium tenui, recta, argentea; capillis ferrugineis. Exp. al. 2½ lin. Head and face reddish-yellow; palpi whitish; antennæ fuscous, basal joint whitish. Anterior wings dull bronzy-grey at the base, shading gradually into a dark purple fascia in the middle; beyond the middle is a straight, shining, rather slender, silvery fascia; the apical portion of the wing is dark purplish-fuscous; cilia fuscous. Posterior wings grey, with grey cilia (Stainton, *Ent. Annual*, 1856, pp. 42-43).

IMAGO.—Head rusty or yellowish. Anterior wings 5-6 mm.; dull bronzy-grey at the base, darkening into blackish-purple (not glossy) transverse bands before and beyond the vertical silvery transverse fascia; the latter just beyond the middle very glossy, and rather narrow; blackish-purple scales project at base of cilia, between these the cilia are fuscous, the tips paler grey. Posterior wings and cilia dark grey.

COMPARISON OF N. CONTINUELLA WITH N. AURELLA.—This species can be readily distinguished from *N. aurella* by the basal portion of the wing, being dull bronzy-grey, instead of rich golden-brown; the fascia, too, is more perpendicularly placed, more slender and more silvery (Stainton).

MINE.—The mine curls and twists about in the vicinity of the site of the egg, forming little bunches of convolutions in the coils of which islets of leafy tissue are caught, and these, being cut off from the general circulation in the leaf, quickly die, so that the mine seems to start from a brown dead patch in the leaf. The mine is irregular in shape, long, greenish in colour, and stuffed as full of coiled frass as is possible, and one is struck not only with the remarkable regularity of the "coils" of frass, but is convinced that by no other means could the frass have been successfully packed away. The mine presents a very perfect example of those with a small transverse capacity and coiled frass, the want of width being the result of the very partial manner in which the parenchyma is removed. The mine is much larger than that of *N. distinguenda*; it is filled with greenish frass, and begins invariably from a brown bunch of convolutions of some size placed at an angle of the midrib; whereas, the other starts from a point, without any series of twists and turns or sign of discoloration, and contains brown frass. The mine is very difficult to see, owing to its retaining so nearly the colour of the leaf (Wood). Heinemann says: "The mine is long, narrow and tortuous, entirely filled up with dark green excrement." The egg is laid on the undersurface near a rib (Wood).

LARVA.—The larva of *N. continuella* presents a well-marked example of borrowed colouring, for so deep and pure a green does it look in the mine, that it is hard to believe that it is in reality a rich yellow. It mines with the back up, but exhibits neither the cephalic ganglia nor ventral cord. It is yellow in colour, though, *in sitû*, it looks green in consequence of the light reflected from the floor of the mine. The body has no visible markings. The head is pale brown.

COMPARISON OF THE MINES AND LARVÆ OF N. CONTINUELLA AND N. LUTEELLA.—Like the mine of *N. distinguenda*, that of *N. continuella* is a very perfect example of those mines, which have a small transverse capacity and coiled frass, the want of capacity in the former depending on the extreme narrowness of the mine, and in the latter upon the very partial manner in which the parenchyma is removed. They can, however, be readily distinguished from each other. *N. continuella* makes a much larger mine, which is filled with greenish frass, and begins invariably from a brown bunch of convolutions of some size, placed at an angle of the midrib, whereas, the other starts from a point without any series of twists and turns or signs of discoloration, and contains brown frass. Utterly unlike in their mines, in their larvæ, *N. continuella* and *N. luteella* are closely related. Both larvæ are yellow, with pale brown heads, and no trace of either cephalic ganglia or ventral cord. The larva of *N. luteella* may be known out of the mine by the urinary tubes, but they are not dark enough to be seen when the creature is in the mine. The larva of *N. continuella*, yellow though it be, looks *in sitû* green, and a very decided green, too, in consequence of the light reflected from the floor of its mine. Both species are double-brooded (Wood).

COCOON.—The cocoons (4) divide into two sets. Two of them are 3 mm. long and 2 mm. wide, and dark red-brown in colour; two others 2·25 mm. long and 1·5 mm. wide, and pale greyish-brown in colour. In outline they are not unlike an almond, but a slight concavity on one side suggests the familiar "mussel" shape of so many of the cocoons of this group. There is no distinct lateral flange, the upper dome-shaped surface rising direct from the edge to the central point. One of the ends is distinctly broader than the other, the pupa emerging from the former. The surface of the cocoon is somewhat roughened, and there is a branching reticulation of a very dark red-brown colour running irregularly over it. The free lateral edges are provided with a quantity of loose fibrous silk, some of it of the same dark colour as that of the cocoon, the remainder considerably paler. The projecting pupa-case is transparent, with a number of small oblong grey spots on the dorsum of the thoracic segments, and a number of imaginal scales adherent around the lines of dehiscence. [Described June 15th, 1898, under a two-thirds lens, from cocoons sent by Dr. Wood.] The smaller cocoons are not unlike the larger (which are those described above) in shape, although in size and colour they are so different. Wood says: "The cocoon varies from dark brown, or blackish-brown, to olive in colour." The cocoon is oval, flat, of a yellowish-brown or pale olive-green (Heinemann).

Food-plant.—*Betula alba*. This species almost restricts itself to the downy variety of the birch, selecting the leaves at the ends of the uppermost shoots (Wood).

Time of appearance.—The species is stated to be double-brooded (Threlfall says that it is single-brooded). Stainton bred an imago on June 26th, 1855, from a larva taken in September, 1854, and the following year he bred the species on August 2nd, in both instances from Lewisham. Heinemann gives the end of September and commencement of October for larvæ. Sang obtained mines at Witherslack on August 12th, 1880, and Threlfall bred imagines from June 2nd-20th, 1879, from larvæ obtained July 15th and August 15th-30th, 1878, at Witherslack.

Localities.—Cambridge: (Meyrick). Dorset: Purbeck and Bloxworth (Bankes). Kent: Lewisham (Stainton). Lancashire: Manchester (Stainton), Preston (Hodgkinson). Hereford: Tarrington (Wood). Norfolk: K. Lynn, uncertain in appearance (Atmore). Westmorland: Witherslack (Sang).

Distribution.—Germany: Frankfort-on-the-Main (Schmid), Brunswick (Heinemann), Silesia (Wocke), Hanover, Breslau (Sorhagen). Netherlands: Friesland, North Brabant (Snellen). Russia: Pichtendahl (Nolcken). Scandinavia: Scania (Wallengren).

NEPTICULA CENTIFOLIELLA, Zeller.

Synonymy.—Species: *Centifoliella*, Zell., "Linn. Ent.," iii., p. 315 (1848); H.-Sch., "Sys. Bearb.," v., p. 351, fig. 827 (1855); Frey, "Linn. Ent.," xi., p. 419 (1857); Sta., "Nat. Hist. Tin.," vii., p. 204, pl. x., fig. 1 (1862); Staud. and Wocke, "Cat.," p. 337 (1871); Hein. and Wocke, "Schmett. Deutsch.," p. 747 (1877); Sand, "Cat. Lep. Auv.," p. 201 (1879); Peyer., "Cat. Lep. Als.," ii., 2nd Ed., p. 164 (1882); Sorhagen, "Die Kleinschmett. Brandbg.," p. 305 (1886); Meyrick, "Handbook," etc., p. 719 (1895); *nec* Sta., "Cat.," p. 29 (1849). *Hodgkinsoni*, Sta., "Ent. Mo. Mag.," xxi., p. 103 [part referring to specimens from Worthing (1884)].

Original description.—*Centifoliella*, Heyden. Alis anterioribus violascenti-fuscis nitidulis, fascia postica argyrea; capillis ♂ nigris, ♀ ferrugineis;* conchula antennarum pallida parva. Diese sehr kleine Art unterscheidet sich von *lemniscella* dadurch, dass die Vorderflügel von der Basis aus bräunlich sind mit etwas violettlichem Glanze, der sich hinter der Binde nur wenig erhöht, von der folgenden grössern durch den viel lebhafteren Glanz der Binde, die auch bei ihr weiter gegen die Spitze gerückt ist. Grösse der allerkleinsten *aurella* (Vorderflügel wenig über eine Linie). Kopf hinten gelbschuppig; der Schopf beim Männchen schwarz, beim Weibchen rostgelb. Augendeckel der braunen, gelblich schimmernden Fühler hellgelblich, wenig über die Haare hervorstehend. Beine braunlich, weiss schimmernd. Vorderflügel grossschuppig, braun (beim Weibchen heller), violettlich glänzend (weniger beim Weibchen); gegen die Spitze nur wenig lebhafter als gegen die Basis am Vorderrande. Die Binde steht wie bei *aurella*, ist silberglänzend, ohne den hohen Glanz der genannten Art. Franzen um die Spitze mit grauen Enden, am Innenrande überall grau. Hinterflügel grau, haarschuppig. Unterseite braungrau, sehr schwach violettglänzend (Zeller, *Linnaea Entomologica*, iii. (1848), pp. 315-316).

---

* It is open to question how far this distinction is really sexual. Fletcher says, he "makes out both 'dark' and 'light' heads in both sexes among the imagines bred by Richardson, from larvæ feeding in sweetbriar at Portland. Of Sussex individuals bred from *Rosa* var. *micrantha* and *R. spinosissima*, all have the heads black or *very* dark fuscous; none has the head of the same colour as that of *N. turicella*, which some of both sexes from Portland have. *N. centifoliella* and *N. hodgkinsoni*, of course, may be mixed."

Imago.—Head ferruginous, tinged with fuscous. Anterior wings 5 mm. in expanse; brown in colour, with a very faint purple tinge, the apex purplish-brown; beyond the middle is a slightly oblique, rather broad fascia, of a yellowish-white or pale golden tint; cilia greyish. Posterior wings and cilia grey.

Comparison of N. centifoliella with N. plagicolella, etc.—This insect is readily distinguished from the two other rose-feeding *Nepticulae*, *anomalella* and *angulifasciella*, but bears considerable resemblance to the sloe-feeding *N. plagicolella* and the hawthorn-feeding *N. ignobilella*. From the former it is distinguished by the browner (less golden-brown) base of the anterior wings, and by the fascia being less shining; from the latter, in which the basal half of the anterior wings is rather of a pale golden-brown, the different colour of that portion of the wing is a sufficient distinction, and, besides, the fascia is more oblique in *N. centifoliella* than in *N. ignobilella*. The position of the fascia serves also to distinguish it from *N. betulicola*, for in *N. centifoliella* it is only a little beyond the middle, whilst in *N. betulicola* it is considerably beyond the middle, just before the violet apex (Stainton).

Egg-laying.—The egg is generally deposited on the underside of a rose-leaf, though sometimes on the upper side.

Mine.—The larva makes a slender sinuous gallery, which from its commencement is not entirely filled up with the black excrement, but has a narrow, empty border on each side of the track. In the latter half of the mine the excrement is brownish (Stainton). Sorhagen describes the mine as "slender, slightly sinuous, almost parallel with the margin of the leaf; the excremental line, black (for some distance brownish), slender, placed in the centre of the gallery."

Larva.—Length 2 lines. Pale amber, darker towards the anal end; dorsal vessel dark green; head brown with two dark brown lobes receding into the prothorax (Stainton). Hodgkinson says that "the full-fed larva is dark brick-red" (*Entom.*, xvii., p. 166).

Cocoon.—The cocoon is spun on the ground, and is of a brownish colour (Stainton). Cocoons of the summer brood may be found like those of *N. anomalella* at the base of a leaf of the food-plant (Fletcher).

Food-plants.—*Rosa rubiginosa* and *R. micrantha*. This has long been recognised as the "sweet-briar" species. Fletcher (at Worthing), and Digby (at Purbeck), however, have bred it from *R. spinosissima*. Stainton gives: *Rosa centifolia*.

TIME OF APPEARANCE.—The species is double-brooded, the imagines appearing in April-May, and again at the end of July, from larvæ that feed up in October, and at the end of June. Mann says that it flies at Brussa in May; Hodgkinson records breeding imagines early in May, 1884, from mines obtained the previous October, at Leyland. Imagines on April 23rd, 1866, and June 7th, 1869, at Cheshunt (Boyd). Threlfall bred imagines on April 12th, 1881, from larvæ obtained at Ashton Park, from September 18th-October 14th, 1880.

LOCALITIES.—CAMBRIDGE: Cambridge (Farren). DORSET: Portland (Richardson), Bloxworth (Cambridge), Purbeck (Digby). HERTS: Cheshunt (Boyd). LANCASHIRE: Ashton Park, nr. Preston (Threlfall), Leyland (Hodgkinson). SUSSEX: downs nr. Worthing and Seaford (Fletcher).

DISTRIBUTION.—Mann records the species from Brussa, in Asia Minor. The European localities are—Austria: Vienna (Herrich-Schäffer). France: Nohaut (Sand). Germany: generally distributed, Stettin, Hamburg, etc. (Sorhagen), Frankfort-on-the-Main (Heyden), Berlin (Bouché), Ratisbon (Hoffmann), Breslau (Heinemann and Wocke), Alsace (Peyerimhoff).

NEPTICULA HODGKINSONI, Stainton (? var. praec. sp.).

SYNONYMY.—Species: *Hodgkinsoni*, Sta., "Ent. Mo. Mag.," xxi., p. 103 (1884); Meyr., "Handbook," etc., pp. 719-720.

ORIGINAL DESCRIPTION.—Exp. alar. 2½-3 lines. Tuft of the head black. Anterior wings, with the entire basal portion, rich golden-brown (with no tinge of purple before the fascia); the fascia placed beyond the middle, nearly perpendicular, bright pale golden; beyond the fascia the apical portion is deep purple with the cilia grey. There are two specimens exactly alike, which both appear to be males. The third specimen is a female, and has the basal portion of the anterior wings paler, more bronzy; the fascia has more of a silvery lustre, and is rather obliquely placed (Stainton, *Ent. Mo. Mag.*, xxi., p. 103).

NOTE ON NEPTICULA HODGKINSONI AND N. CENTIFOLIELLA.—*N. centifoliella* and *N. hodgkinsoni* are another pair of more or less doubtful species. Fletcher writes, in answer to a query of ours: "The mine in *Rosa spinosissima* (*E.M.M.*, xxi., p. 103), I now refer to *N. centifoliella*. It is the same species as I bred from the small flowered sweet-briar (*R. rubiginosa* subsp. *micrantha*), nr. Worthing, and from *R. spinosissima*, nr. Seaford. I am not, however, fully convinced that *N. hodgkinsoni* is distinct from this species. The Portland species from "sweet-briar" has been identified as *N. centifoliella*. Many of the latter have the head *bright* "ferruginous," some black (*Nat. Hist. Tin.*, vii., p. 208). Most of my examples from Sussex have heads "black," rarely "blackish-fuscous."

LARVA.—Yellow (Threlfall).

TIME OF APPEARANCE.—Bred in June, 1884, from larvæ found mining in the leaves of roses the previous autumn. Threlfall bred imagines on May 20th, 1881, from larvæ taken at Preston, August 20th, 1880.

FOOD-PLANT.—Bred from ordinary-sized rose leaves, thus not to be mistaken for the leaves of *R. spinosissima*, which, moreover, does not grow at Leyland (Stainton).

LOCALITIES.—LANCASHIRE: Leyland, nr. Preston (Hodgkinson).

NEPTICULA BETULICOLA, Stainton.

SYNONYMY.—Species: *Betulicola*, Sta., "Ent. Ann.," 1856, p. 42; "Man.," ii., p. 436 (1859); Frey, "Die Tineen," etc., p. 387 (1856); "Linn. Ent.," xi., p. 424 (1857);

Hein., "Wien. Monats.," 1862, p. 303; Hein. and Sta., "Zool.," 1863, p. 8369; Nolck., "Lep. Fn. Estland," p. 773 (1871); Staud. and Wocke, "Cat.," p. 337 (1871); Hein. and Wocke, "Schmett. Deutsch.," p. 748 (1877); Sand, "Cat. Lep. Auv.," p. 201 (1879); Wallgrn., 'Ent. Tids.," ii., p. 127 (1881); Bang-Haas, "N. H. Tids.," xiii., p. 217 (1881); Peyer., "Cat. Lep. Als.," 2nd Ed., ii., p. 164 (1882); Snellen, "De Vlinders," etc., p. 991 (1882); Sorhagen, "Die Kleinschmett. Brandbg.," p 306 (1886); Hering, "Stett. Ent. Zeit.," lii., p. 220 (1891); Meyr., "Handbook," etc., p. 720 (1895).

Original description.—Alis anticis fusco-æneis, apice purpureo-tincto, fascia postica argenteo albida; capillis luteis, fusco-mixtis. Exp. al. 2 lin. Head and face yellowish, slightly mixed with fuscous; antennæ fuscous, basal joint whitish. Anterior wings bronzy-brown, considerably beyond the middle is a silvery-whitish fascia, of variable breadth, placed nearly perpendicularly; the apical portion of the wing is purplish-brown; cilia fuscous. Posterior wings grey, with grey cilia (Stainton, *Ent. Annual*, 1856, p. 42).

Imago.—Head ochreous. Anterior wings 5 mm.; bronzy-brown, the tip purplish-brown; considerably beyond the middle of the wing a whitish fascia, nearly straight; cilia purple-grey tipped with whitish grey, at the anal angle darker. Posterior wings and cilia grey.

Sexual dimorphism.—The males are rather smaller and browner; frequently the fascia does not extend quite to the costa, and the head is fuscous, with white eye-caps. The females are purplish from the base to the fascia, which extends quite to the costa, and the head is yellow. The insect varies in intensity of colour with the temperature and climatic conditions of the season. Some years ago, in a hot summer, I bred some as brilliant as *N. alnetella* (Threlfall). In the male, the frontal tuft is pale luteous-yellow, sometimes almost dirty-white, the small cervical tuft still paler, the eye-caps small and silvery-white; in the female, the frontal tuft is bright ochreous-yellow, the cervical tuft luteous, the larger eye-caps are pale yellow with a silvery gloss (Heinemann).

Variation.—The moths that I bred in September, 1894, from larvæ feeding in leaves of *Betula nana*, and sent to me from Rannoch, by Salvage, may be this species, but they are smaller, have black heads in both sexes, and the fascia is distinctly more silvery and less golden, and the apical cilia have more whitish scales, especially near the costa, than those bred from *B. alba*, and obtained in Tilgate Forest and Abbott's Wood. I am by no means convinced that the northern insect is identical with our southern *N. betulicola* (Fletcher).

Comparison of N. betulicola with N. microtheriella, N. plagicolella, etc.—The fascia of *N. betulicola* is more posteriorly placed than in *N. microtheriella*, in the latter, too, the fascia is not shining; in *N. betulicola* it is perceptibly silvery (Stainton). This species is most nearly allied to *N. plagicolella*, and is sometimes very difficult to distinguish from it, but the latter has the frontal tuft much brighter ferruginous, and the antennæ are longer, reaching in the female to the middle of the anterior wings, and in the male perceptibly beyond the middle; besides, in *N. plagicolella*, the ground colour of the anterior wings is more bronzy, paler and more glossy, and not so inclined to black-grey; before the fascia there is a more decided violet tinge; the base, on the other hand, is always rather paler, dull bronze-colour; the fascia is, just beyond the middle of the wing, rarely as narrow as in *N. betulicola*, and has a more decided metallic lustre; the cilia are decidedly of a darker grey; moreover, in *N. plagicolella* the middle tibiæ are not paler than the other legs. *N. microtheriella* may be distinguished by the narrower anterior wings, suffused with violet, and before the tip almost of a pure blue, by the narrow, rather oblique fascia, and by the darker grey cilia. *N. luteella* has the disc of the anterior wings less smooth and dull, the fascia is not placed so posteriorly, and perceptibly expands on the inner margin, inclining to yellowish with very slight glossiness (Heinemann).

Mine.—The mine is small, narrow and coarse at the commencement, generally much contorted and several are often crowded together in a leaf. The black frass is deposited in the gallery without any order, and is deposited differently in different mines; usually it does not much more than half fill the gallery, sometimes it almost does so, the mine at the same time often being narrower and shorter than usual, and coming very near the mine of *N. luteella*. The irregularity appears to depend on the nature of the leaves, for it will be found that the latter are appreciably thinner, and their network of veinlets more open where the gallery is only half filled, than where it is more completely filled (Wood). Threlfall says that " the mine is filled with brown excrement," but Douglas remarks that the mine is filled with brown excrement in the latter half of the mine only, the excrement being greenish-grey in the central portion. Heinemann notes that the mine is rather broad, tortuous, with a loose excremental track in the middle. Frey writes: " Die Mine ist ein mässig langer und gewundener schmaler Gang, welcher von der breiten, bräunlichen Kothlinie gänzlich erfüllt ist (*Die Tineen*, etc., p. 387).

Larva.—The larva is bright yellow in colour, with a brown head, and distinctly green dorsal vessel. It mines with the venter up, and thus shows distinctly the ventral cord which forms a chain of inconspicuous, linear markings. There is a superficial skin mark on the venter of the prothorax, this spot and the ventral cord being brown in colour, not black as in the larva of *N. distinguenda*. Frey says: " The larva is 2 lines in length. It is very dirty yellow in colour, with a darker alimentary canal showing through. It has a light brown head."

Cocoon.—The cocoons (4) average 2·25 mm. in length and 1·75 mm. in width. There appears to be some variation in shape, one of the cocoons being somewhat of the typical " mussel " shape, the others rather oblong-oval in outline, one particularly so. There is a somewhat flattened flange at the wider end, from which the dome-shaped portion rises gradually, at the other end more rapidly. The raised portion is red-brown in colour, the flange ochreous. The surface is somewhat smooth on the raised portion, rougher, and covered with loose, flossy pale silk along the flanged edge. [Described June 15th, 1898, under a two-thirds lens, from cocoons sent by Dr. Wood.] Wood says: " The cocoon is usually spun up on the surface of the ground, and is brownish-ochreous in colour." Frey describes it as: " Länglich rund, ockerfarben, ziemlich flach und glatt." Heinemann notes it as being " yellowish-brown, flat, generally rather broader at one end." Cocoons received from Fletcher, made by larvæ that had fed on *B. nana*, are somewhat yellower and brighter in colour than those received from Wood, but otherwise, in form, structure, and general appearance, they appear to be identical.

FOOD-PLANTS.—Birch (*Betula alba*) and probably *B. nana*. This species much prefers little seedling plants, and is often very scarce on the taller trees, whilst abundant at the ground level (Wood). Heinemann has counted as many as twenty-five larvæ in a single leaf of *B. alba*. Threlfall notes that this species affects "low birches on mosses."

TIME OF APPEARANCE.—The species is double-brooded, appearing in May and August, from larvæ that have fed up the previous September-October and July respectively. Mines were found commonly on Oct. 11th, 1892, at Darenth, and Oct. 13th, 1893, at Chislehurst (Bower). Larvæ were found at Witherslack on August 5th, 1877, and produced imagines in May, 1878; other larvæ from Oct. 1st-20th, 1878, at Grange, and again on July 6th, 1879, at Witherslack, the latter produced imagines August 15th (Threlfall). We have imagines bred by Threlfall, from larvæ obtained at the same place Sept. 2nd, 1886. Mines were obtained by Sang on Oct. 7th, 1857, at Barnard Castle; Oct. 8th, 1874, Aug. 17th, 1877, Oct. 29th, 1879, at High Force; July 13th, 1878, Aug. 22nd, 1880, at Witherslack; Oct. 14th, 1878, at Wolsingham (*teste* Gardner). Frey writes: "Die Spuren der Sommerbrut fand ich im letzten Sommer am 18th August bei Bremgarten in den verlassenen Minen. Die zweite Generation findet sich hier bei Zürich zu Ende September und in der ersten Oktoberhälfte, weniger an kleinen Büschen als jüngeren Bäumen. Im Herbste 1855 war die Mine selten, im folgenden Jahre ziemlich häufig und an unseren benachbarten Bergen bis etwa 1000 Fuss über die Thalsohle zu verfolgen." Stainton bred imagines from May 1st-17th, 1870, from Perth larvæ.

LOCALITIES.—CHESHIRE: Bowdon (Edleston). DORSET: Purbeck and Bloxworth (Bankes). DURHAM: Barnard Castle, High Force, Wolsingham (Sang). HEREFORD: Tarrington (Wood). KENT: West Wickham (Stainton), Darenth and Chislehurst (Bower). LANCASHIRE: Manchester (Stainton), Grange and Preston (Threlfall). LEICESTER: Market Harborough (Matthews), Whitwick (Sang). NORFOLK: King's Lynn (Atmore). PERTHSHIRE: Moncrieffe Hill (Moncrieffe), Rannoch [I refer a *Nep.* locally abundant on *Betula nana* to this species (Fletcher)]. Ben Chearan and Strathglass on *B. nana* (White *teste* Stainton). SURREY: Headley Lane (Douglas), Mickleham (Stainton). SUSSEX: Abbott's Wood and Tilgate Forest (Fletcher). WESTMORLAND: Witherslack (Sang). YORKS: Richmond (Sang), Sheffield (Doncaster).

DISTRIBUTION.—Denmark: North-east Zealand (Bang-Haas). France: Sommerère, Sologne-du-Cher (Sand). Germany: generally distributed in N. Germany (Heinemann and Wocke), Alt Damm, Friedland (Hering), Brunswick and Hanover (Heinemann), Jungfernheide, Hamburg (Sorhagen), Saverne (Peyerimhoff). Netherlands: various localities in Gelderland and N. Brabant (Snellen). Russia: Pichtendahl, Tursa Moor (Nolcken), Aland (Reuter). Scandinavia: Scania (Wallengren). Switzerland: Bremgarten, nr. Zürich (Frey).

NEPTICULA PLAGICOLELLA, Stainton.

SYNONYMY.—Species: *Plagicolella*, Sta., "Ins. Brit.," pp. 303-304 (1854); "Nat. Hist. Tin.," i., p. 160, pl. iv., fig. 1 (1855); "Man.," ii., p. 437 (1859); H.-Sch., "Sys. Bearb.," v., p. 350 (1855); Frey, "Die Tineen," etc., p. 387 (1856); "Linn. Ent.," xi., p. 426 (1857); Staud. and Wocke, "Cat.," p. 337 (1871); Nolck., "Lep. Fn. Estl., p. 775 (1871); Hein. and Wocke, "Schmett. Deutsch.," p. 750 (1877); Sand, "Cat. Lep. Auvergne," p. 201 (1879); Erschoff, "Trudy Russ. Ent. Soc.," xii., p. 221 (1881); Wallgrn., "Ent. Tids.," ii., p. 127 (1881); Peyer., "Cat. Lep. Alsace," 2nd Ed., ii., p. 164 (1882); Snellen, "De Vlinders," p. 990 (1882); Sorhagen, "Die Kleinschmett. Brandbg.," p. 306 (1886); Hering, "Stett. Ent, Zeit.," lii., p. 220 (1891); Meyrick, "Handbook," etc., p. 720 (1895).

Original description.—*Nepticula plagicolella*, n. sp. Alis anticis nitidis fuscis, postice purpureo-tinctis, fascia fere recta pone medium nitida, albida, parum argentea; capillis ferrugineis. Exp. al. 2 lin. Head and face reddish-yellow. Palpi whitish. Antennæ fuscous, basal joint whitish. Anterior wings shining fuscous, with a purple tinge, which begins before the middle of the wing; beyond the middle is a nearly straight, shining, whitish, rather silvery fascia; cilia fuscous. Posterior wings pale grey, with pale grey cilia. Appears in May and August, but I believe not hitherto met with in the perfect state. The larva mines in the leaves of sloe in autumn and July, making large whitish blotches; in some places it is exceedingly plentiful; the cocoon is rather flat (Stainton, *Insecta Britannica*, pp. 303-304).

Imago.—Head reddish. Anterior wings 4-5 mm.; shining fuscous, with a purple tinge nearly from the base; beyond the middle is a nearly straight, shining, rather silvery, transverse fascia; cilia dark blackish-grey. Posterior wings and cilia pale grey.

Comparison of N. plagicolella with N. betulicola, etc.—This species is nearer to *N. betulicola* than to any other of the species already dealt with. In the latter the head-hairs are paler, the cilia of the fore-wings lighter and purer grey, the transverse band less shining and placed beyond the centre, at least two-thirds of the length of the wing from the base, whilst in *N. betulicola* the transverse band is nearer the centre of the wing. Its resemblance also to *N. microtheriella* may lead to confusion, but this species is smaller, the head-hairs are not reddish, but ochreous; the fore-wings and the band, too, are less shining, the latter is silvery and placed more obliquely. It also resembles *N. centifoliella*; the head of the rose-miner, however, is lighter, more yellowish, and it is somewhat broader-winged, whilst the colour of the fore-wings is less dark, and the band less shining, in those specimens which most resemble *N. plagicolella* in breadth and form of wing. The transverse band of *N. centifoliella*, too, is probably placed somewhat further beyond the middle of the wing than in *N. plagicolella*, and, lastly, the fringes are brown-black, darker than in *N. plagicolella*, yet, it must be confessed that the separation of the two species does not appear to me to be easy (Frey). Stainton notes that *N. plagicolella* "belongs to that section of the genus in which there is a single brilliantly metallic fascia on the anterior wings; the whitish silvery colour and the nearly straight direction of the fascia, at once separate it from most of the allied species, and the reddish-yellow colour of the head distinguishes it easily from the fuscous-headed *N. acetosae*, and the black-headed *N. prunetorum*."

Egg-laying.—The egg is laid on the upper side of a sloe leaf.

Mine.—When newly-hatched, the larva commences a long and extremely slender mine, which, being filled with blackish excrement, appears almost as a crooked black line; but, after continuing in this linear track for some distance, the larva mines a complete blotch of an irregular oval figure, and of a pale greenish-white colour; in the central portion of this blotch the black excrement forms a little heap; not unfrequently two larvæ, mining in the same leaf, will meet at the blotched portion of the mine, and have a larger blotch in common. The larva leaves its mine to spin its cocoon (Stainton). Frey writes: "Die Mine, in welcher zuweilen zwei Räupchen angetroffen werden,

beginnt als ein sehr feiner, von der braunschwarzen Kothreihe ganz erfüllter Gang, welcher dann plötzlich in einen unbestimmt rundlichen, oft stark ausgebuchteten, grünlich weissen Fleck übergeht, worin die Excremente einen unregelmässigen Haufen bilden." Sorhagen writes: "Die Fleckenmine entwickelt sich plötzlich aus einer feinen langen Gangmine, die mit schwarzem Kothe ganz gefüllt ist, während sie selbst grünlichweiss ist und den Koth in einem Haufen in der Mitte hat. Oft bilden 2 Raupen eine gemeinschaftliche grössere Blatter mit 2 Kothhäufchen."

LARVA.—Length 2 lines. Pale amber, shining, transparent, dorsal vessel slightly greener; head small, reddish-brown, working up under the prothorax, through the upper surface of which the posterior part can be distinctly seen (Stainton). Frey writes: "Die Larve in den beiden Generationen, der sommerlichen (bei uns schon in der zweiten Junihälfte) und der herbstlichen, bis tief in den Oktober hinein an Schlehen (*Prunus spinosa*) und auch an Zwetschenbäumen (*Prunus domestica*). Sie ist blassgelb mit dunkler durchschimmerndem Darmkanale und einem röthlich-braunen Köpfchen."

COMPARISON OF THE LARVA AND MINE OF N. PLAGICOLELLA WITH THOSE OF N. PRUNETORUM.—The larva of *N. plagicolella* is yellow, and makes a clear whitish blotch, preceded by a slender gallery. The larva of *N. prunetorum* is green, and its mine is coiled like a watch-spring, afterwards extending round the edge of the leaf; the "frass" fills up the gallery, and makes it light brown (Threlfall).

COCOON.—The cocoons (7) average 3 mm. in length and 1·75 mm. in width, forming a long oblong-oval. There is a wide flange round three sides of the cocoon, one of the long sides being, however, almost devoid of it. This side rises almost directly to the highest point of the domed surface which surmounts the flange, the elevation being more gradual on the other sides. The domed area is comparatively smooth, with a few fine, slender, irregular reticulations, rather darker than the ground-colour; the latter is ochreous-brown, inclining to yellowish. There is a considerable amount of loose flossy silk of the same colour as the silk of the cocoon scattered over the flange, a similar, but much thinner, coating covering the domed surface. [Described June 16th, 1898, under a two-thirds lens, from cocoons sent by Dr. Wood.] Stainton describes the cocoon as "brown, rather flat, especially at the edges, and in shape not far from circular; the pupa protrudes its anterior segments through the end of the cocoon previous to the escape of the imago." Frey writes: "Der lebhaft rothbraune Cocon ist glatt, rundlich und sehr stark abgeflacht."

FOOD-PLANTS.—*Prunus spinosa* and *P. domestica*. Fletcher adds: Abundant in sloe, in garden plums, in *Prunus myrobalana*, *P. divaricata* var. *pissardii* and *P. japonica* (*sinensis*).

TIME OF APPEARANCE.—There are two broods, the imagines appearing in May, June and August, the larvæ of these feeding respectively in September-October. and July-August. Stainton bred imagines, from Lewisham, on July 12th-29th, 1852, from larvæ found at the end of June, 1852; July 28th-August 21st, 1853; April 10th-30th, 1854; May 2nd-11th, 1855; also from larvæ taken at Cheshunt, April 30th, 1854; imagines were caught at Dartford, June 22nd, 1852, and at Lewisham, flying along hedges, from 5.30 a.m. to 6.30 a.m., on May 16th, 1852. Mines were found in sloe, on October 5th, 1891, at

Darenth, October 25th, 1892, at Eltham, October 2nd, 1892, at Lewisham, and in plum (as well as sloe), on September 26th, 1895, at Lewisham (Bower). Jordan notes the conspicuous blotches made by the larva of this species on the sloe. at Haldon, on September 21st, 1865. Threlfall bred it from May 24th-30th, 1879, from larvæ obtained at Grange on October 5th, 1878. Nolcken found imagines on June 24th, 1862, at Pichtendahl (Fletcher).

Localities.—Bucks: Loudwater (Boyd). Cambridge: Cherryhinton (Farren). Cheshire: Bowdon (Edleston). Derby: Henhurst (Sang). Devon: Haldon (Jordan), Dawlish (Stainton). Dorset: Portland and Weymouth (Richardson), Purbeck (Bankes). Dublin: Artone, Dunnycarney (Birchall). Durham: Darlington (Sang). Herts: Cheshunt (Boyd). Hereford: Tarrington (Wood). Kent: Lewisham, Dartford Heath (Stainton), Darenth and Eltham (Bower). Lancashire: Manchester (Stainton), Preston and Grange (Threlfall). Norfolk: common and widely distributed in West Norfolk, King's Lynn, etc. (Atmore). Suffolk: Rendham (Bloomfield), Lowestoft (Boyd). Sussex: Worthing, abundant (Fletcher), Guestling (Bloomfield). Westmorland: Witherslack (Threlfall). Yorkshire: Scarborough and Richmond (Sang), Doncaster (Warren).

Distribution.—France: Nohaut, Indre (Sand). Germany: generally distributed (Heinemann and Wocke), Potsdam, Havelland, Friedland, Hamburg (Sorhagen), Frankfort-on-Main (Schmid), Brunswick (Heinemann), Alsace (Peyerimhoff), Alt Damm, Jubo (Hering). Netherlands: Groningen, Drenthe, Gelderland, N. Brabant (Snellen). Russia: Finland (Wocke), St. Petersburg (Erschoff), Pichtendahl (Nolcken). Scandinavia: Scania (Wallengren). Switzerland: Zürich, Baden, Bremgarten (Frey).

NEPTICULA MICROTHERIELLA, Stainton.

Synonymy.—Species: *Microtheriella*, Sta., "Ins. Brit.," p. 302 (1854); "Nat. Hist. Tin.," i., p. 118, pl, ii., fig. 3 (1855); "Man.," ii., p. 435 (1859); H.-Sch., "Sys. Bearb.," v., p. 350 (1855); Frey, "Die Tineen," etc., p. 386 (1856); "Linn. Ent.," xi., p. 419 (1857); Staud. and Wocke, "Cat.," p. 337 (1871); Nolck., "Lep. Fn. Est.," p. 772 (1871); Hein. and Wocke, "Schmett. Deutsch.," p. 747 (1877); Sand, "Cat. Lep. Auvergne," p. 201 (1879); Bang-Haas, "N. H. Tids.," xiii., p. 217 (1881); Peyer., "Cat. Lep. Alsace," 2nd Ed., ii., p. 164 (1882); Snellen, "De Vlinders," p. 992 (1882); Sorhagen, "Die Kleinschmett. Brandbg.," p. 305 (1886); Meyr., "Handbook," etc., p. 720 (1895); Kirby, "Handbook," etc., vol. v., p. 314 (1897).

Original description.—*Nepticula microtheriella*, Wing, n. sp. Alis anticis fuscis, paullulum purpureo-tinctis, praecipue apicem versus, fascia tenui, subobliqua pone medium albida; capillis luteis, fusco-mixtis. Exp. al. $1\frac{3}{4}$ lin. Head and face yellowish, slightly mixed with fuscous. Palpi whitish. Antennæ fuscous, basal joint whitish. Anterior wings fuscous, slightly tinged with purple, especially towards the apex; beyond the middle is a slightly oblique, rather slender, whitish fascia; cilia fuscous. Posterior wings grey, with paler cilia. The smallest known lepidopterous insect. Appears in May and August, but rarely met with in the perfect state; the small yellowish-green larva makes extremely narrow tortuous galleries in the leaves of the nut and hornbeam, occurring in autumn and July. It is sometimes so abundant that upwards of thirty may be found in a single leaf. The rather firm cocoon is of a pale buff colour (Stainton, *Insecta Britannica*, p. 302).

Imago.—Head ochreous. Anterior wings 3-4 mm.; fuscous slightly tinged with purple, especially towards the tip; beyond the middle is a slightly oblique, rather slender, whitish, transverse fascia; cilia blackish-grey. Posterior wings grey with paler cilia.

Comparison of N. microtheriella with the allied species.—*N. microtheriella* belongs to that section of the genus in which there is a single distinct pale fascia on each of the anterior wings, but the fascia is not brilliantly metallic; indeed, in this species, the fascia is less shining than in any of the allied species, and it may by this character alone be readily distinguished from *N. ignobilella*, *N. plagicolella*, *N. tityrella* and *N. malella*, in all of which the fascia is perceptibly shining. From *N. argentipedella* and *N. acetosae* it can be distinguished by the more yellowish colour of the fascia, which is more obliquely placed than in *N. acetosae;* at the same time, the size alone of *N. argentipedella* would sufficiently distinguish it from *N. microtheriella*, which is certainly the smallest lepidopterous insect at present known (Stainton). Fletcher notes that imagines of *N. poterii* and *N. filipendulae* are quite as small as those of *N. microtheriella*, whilst those of *N. acetosae* are much smaller. In a very long series, Fletcher says that he has not a single *N. acetosae* as large as his smallest specimen of *N. microtheriella*.

Egg-laying.—The egg is deposited on the underside of a leaf of nut or hornbeam, generally close to a rib, and almost entirely concealed by the projection of the rib, and the short hairs to be found on the back of the nut-leaf. It is rather more conspicuous when laid on a leaf of hornbeam.

Mine.—The larva commences its extremely narrow mine, proceeding in a straight line close along a rib, and then turning off at a sharp angle, when it meets another rib; at times it crosses from one rib to another, its path then being irregular and sinuous; the excrement forms a slender black line, which gradually becomes thicker, and manifestly formed of individual grains; it is occasionally interrupted for short distances, but never loses its linear appearance; the mine appears on either side as a slender whitish-green streak. The larva leaves the mine to pupate (Stainton). Frey writes: "Die Mine ist ein sehr dünner, ausserordentlich langer Gang, in welchem eine sehr feine Kothlinie die Seitenränder nicht erreicht. In dem Haselblatte verläuft sie in unregelmässigen Windungen, oft mit einer zweiten und dritten Mine sich kreuzend. In Hainbuchenblättern dagegen läuft sie in starken, winkligen Biegungen, z. B. eine Strecke dem Rande entlang, dann dicht neben einer Seitenrippe hin bis zur Mittelrippe, von welcher sie sich dann plötzlich umbiegend wieder entfernen kann" (*Die Tineen*, etc., p. 386).

Larva.—Length 1½ lines; very pale amber, with the dorsal vessel dark green, giving, at first sight, the larva a greenish appearance, the 7th and 8th abdominal segments reddish; head pale reddish-brown, the hinder part showing through the prothorax (Stainton). The larva mines with the venter uppermost.

Comparison of the larvæ of N. microtheriella and N. floslactella.—Sie ist als Raupe und nach der Mine nicht ganz leicht von *N. floslactella* zu trennen, mit der sie bei uns gleichzeitig in den Blättern von *Corylus avellana* lebt, an deren Unterseite die Eier beider Arten gelegt werden. Die Raupen beider sind blass gelb, aber in veränderlichen Nüancen, mit grünem Darm, welcher dem ganzen Leibe mehr oder weniger einen grünlichen Schein giebt; im Allgemeinen ist *N. microtheriella* als Raupe die blasser gefärbte, namentlich ist ihr bräunlicher Kopf, der manchmal fast farblos wasserhell sein kann, immer viel heller als bei *N. floslactella*, deren Kopf besonders nach hinten ziemlich intensiv braun gefärbt ist (Nolcken).

Cocoon.—The cocoons (8) average 2·1 mm. in length and 1·6 mm. in width. There is some variation in shape, but most of the examples examined form a rough oval in outline, narrowed towards one end. This variation is possibly due to an exceedingly thick coating of loose flossy silk, in which the cocoon proper is enveloped, being unequally distributed over it. The broad part of the cocoon appears to be flanged, although this is to a certain extent hidden by the flossiness of the outer coat. This end, too, is thinner, but gradually rises to meet the more swollen portion of the cocoon at the narrower end. The inner cocoon is closely woven and apparently tough. There is much variation in the colour; the normal tint is yellow-brown, but some of the cocoons have a strong suspicion of bright orange, whilst one or two of them are inclined to be greyish. [Described June 16th, 1898, under a two-thirds lens from cocoons sent by Dr. Wood.] Stainton describes the cocoon as being "of a pale buff colour, rather egg-shaped, the whole of it firmly woven, with no flossy exterior, and considerably smaller than that of *N. floslactella*." Frey writes: "Der Cocon oval, klein, platt, ist von Hainbuchenraupen weisslich gelb, von Haselräupchen dunkel ockerfarben."

Food-plants.—*Corylus avellana* and *Carpinus betulus*.

Time of appearance.—The species is double-brooded, the imagines appearing in May and August, from larvæ to be obtained in October and July respectively. Stainton bred imagines on February 1st-2nd, March 25th, April 14th-22nd and August 2nd-6th, 1853; April 25th, 1854; April 3rd-4th and November 2nd, 1855, and April 28th, 1858. He captured imagines on palings at Beckenham, on June 17th, 1851, and at Lewisham, May 8th, 1848. The larvæ are sometimes so exceedingly abundant in October that a single nut-leaf has been known to contain thirty mines. Machin records the larva in the middle of September, at Plumstead; Bower, on October 11th, 1892, at Darenth. Nolcken records the larvæ from August 24th to September 27th, at Rotsiküll and Pichtendahl. Threlfall bred imagines on May 16th, 1878, from larvæ obtained at Grange, October 6th, 1877. We observed full-fed larvæ near Chatham on July 9th, 1898.

Localities.—Cambridge: Cambridge (Farren). Cheshire: Bowdon (Edleston). Derby: Burton (Sang). Dorset: Purbeck (Bankes), Glanvilles Wootton (Dale), Bloxworth (Cambridge), Weymouth (Richardson). Durham: Darlington (Stainton). Gloucester: Bristol (Stainton). Hereford: Tarrington (Wood), Kent: Lewisham, Beckenham (Stainton), Chatham (Tutt), Darenth (Bower), Plumstead (Machin). Lancashire: Manchester (Stainton), Grange (Hodgkinson). Norfolk: Horstead (Barrett), King's Lynn (Atmore). Northumberland: Newcastle (Stainton). Somerset: Clevedon (Mason). Suffolk: Great Glenham (Bloomfield). Surrey: Croydon (Elisha). Sussex: common in the county (Fletcher), Guestling (Bloomfield). Yorks: Doncaster (Corbett), Harrogate and Richmond (Sang), Scarborough (Stainton), Sheffield (Doncaster), York (Wilson).

Distribution.—Denmark: North Zealand (Bang-Haas). France: Sommerère, Sologne-du-Cher (Sand). Germany: generally distributed (Heinemann and Wocke), Frankfort-on-the-Main (Schmid), Berlin, Friedland, Hamburg, Stettin (Sorhagen), Alsace (Peyerimhoff). Netherlands: S. Holland, Friesland, Drenthe, Overijssel, Gelderland, N. Brabant (Snellen). Russia: I. of Aland (Reuter), Rotsiküll, Pichtendahl (Nolcken). Switzerland: nr. Zürich (Frey), Bremgarten (Boll).

NEPTICULA IGNOBILELLA, Stainton.

Synonymy.—Species: *Ignobilella*, Sta., "Cat. Brit. Tin.," p. 29 (1849); "Ins. Brit.," p. 302 (1854); "Nat. Hist. Tin.," i., p. 246, pl. vii., fig. 1 (1855); "Man.," ii., p. 434 (1859); H.-Sch., "Sys. Bearb.," v., p. 350 (1855); Frey, "Linn. Ent.," xi., p. 414 (1857); Constant, "Mem. Nat. Hist. Autun," xii., p. 354 (1866); Sand, "Cat. Lep. Auvergne," p. 201 (1879); Wallgrn., "Ent. Tids.," ii., p. 127 (1881); Snellen, "De Vlinders," etc., p. 988 (1882); Wood, "Ent. Mo. Mag.," xxx., p. 47 (1894); Meyr., "Handbook," etc., p. 721 (1895). *Ignobiliella*, Staud. and Wocke, "Cat.," p. 337 (1871); Sorhagen, "Die Kleinschmett. Brandbg.," p. 345 (1886).

Original description.—*Nepticula ignobilella*, Sta. ? *Posticella*, Haw., St. Much less brilliant than *N. aurella*. Basal portion of the wing brownish; apex violet; fascia placed as in *aurella*, whitish, not silvery; head of the ♂ black; of the ♀ ferruginous (Stainton, *Sys. Cat. Brit. Tin. and Pterophoridae*, p. 29). This was extended[*] by Stainton, in the *Insecta Britannica*, pp. 302-303, where he writes as follows: "*N. ignobilella*, Sta., *Cat.*, p. 29 (1849); ? *aurella* var. *β*, Haw.; ? *posticella*, St. Alis anticis dilute aureo-brunneis, apicem versus purpureo-tinctis, fascia recta pone medium, parum nitida, luteo-albida; capillis ferrugineis. Exp. al. 2¼ lin. Head and face reddish-yellow. Palpi whitish. Antennæ fuscous, basal joint whitish. Anterior wings pale golden-brown; beyond the middle is a straight, yellowish-white, slightly shining fascia; the apex of the wing has a purplish tinge; cilia fuscous. Posterior wings pale grey, with pale grey cilia. Appears in May and August, but not frequently met with. The yellowish larva mines in hawthorn leaves in autumn and July, but has not at present been distinguished from the larvæ of *N. pygmaeella* and *N. gratiosella*."

Imago.—Head reddish. Anterior wings 5 mm.; pale golden-brown; a straight yellowish-white, slightly shining, transverse fascia beyond the middle; the apex of the wing tinged with purplish; cilia fuscous. Posterior wings and cilia pale grey.

Comparison of N. ignobilella with its allies.—*N. ignobilella* belongs to that section of the genus in which the dark anterior wings have a single shining pale fascia. In this section it may be distinguished by the anterior wings from the base to the fascia being entirely of a pale golden-brown, resembling *N. aurella* in colour, only paler, and without the purple tinge beyond the middle, which we notice in *N. aurella*, *N. plagicolella*, etc. The straightness of the fascia distinguishes it readily from *N. tityrella*, and the greater breadth and glossiness of the anterior wings separate it from *N. microtheriella* (Stainton).

Egg-laying.—The egg is laid on the under (Stainton adds "rarely on the upper") surface of a hawthorn leaf, well away from the edge, and often quite in the middle of the leaf.

Mine.—The mine forms a pale blotch near the edge of a hawthorn leaf, and in the mine is a slender irregular track of black excrement. The larva commences to mine in a very slender gallery towards the edge of the leaf, frequently keeping close to the edge for some time. In this first portion of its mine the excrement forms a black line of gradually increasing thickness, occupying half of the width of the mine; but the larva now ceases to mine in a slender gallery, but forms a large irregular blotch, along the centre of which the excrement is rather irregularly placed; the larva thus mines from the edge towards the mid-rib of the leaf, whereas the larva of *N. pygmaeella* is at the same age proceeding in an exactly opposite direction, *viz.*, moving away from the midrib. These two larvæ have a considerable resemblance, but the mines may be at once distinguished by the colour of the excrement. When the larva is full-fed, it leaves the mine by passing through the upper cuticle of the leaf (Stainton). Wood writes: "The gallery is fairly long and slender, and rarely occurs in the body of the leaf; it wanders at first about the area of a lobe before it reaches and follows the edge, and though this wandering portion is afterwards absorbed by the blotch with which the mine finishes, the fine frass-track remains undisturbed as evidence of its former existence; the frass of *N. ignobilella* is black, both in the gallery and blotch."

---

[*] Stainton writes: "An indifferent description of this species, which was not then distinguished from some of its allies, occurs in Stainton's *Cat. of Brit. Tineidae*, p. 29, but the only definite description yet extant is that in the *Insecta Britannica*, etc., p. 302, where the name is restricted to the species" (*Nat. Hist. Tin.*, i., p. 252).

Comparison of the mine of N. ignobilella with that of N. regiella.—The blotch-miners, *N. regiella* and *N. ignobilella* occur together at about the same time, and are double-brooded, feeding in the summer, and again late in the autumn. The small blotches that they make at the tips of the lobes, with their yellow or yellowish larvæ, are certainly most provokingly similar, unless attention be paid to one or more of the following points, when their discrimination becomes as easy and pleasant as it before seemed impracticable. In both the egg is laid on the underside, in *N. regiella* quite on the edge, in *N. ignobilella* well away from it. As a consequence, the whole course of the primary gallery of the former runs along the edge, whereas the gallery of the latter wanders at first about the area of the lobe before it reaches and follows the edge, and though this wandering portion is afterwards absorbed by the blotch, the fine frass-track remains undisturbed and is evidence of its former existence. Next, *N. regiella* deposits brown frass in its gallery and black in the blotch, whereas the dejecta in *N. ignobilella* are black in both gallery and blotch. Lastly, the head of the larva of *N. regiella* is pale brown, with the cephalic ganglia dark brown, and consequently far more conspicuous than the head; on the other hand, the head of *N. ignobilella* is blackish, overpowering the ganglia, which are of a paler colour. I should add that a pair of brilliant orange spots are frequently present on the front edge of the 2nd segment in *N. regiella*. I was inclined at one time to think that they might be a sexual distinction, but careful breeding lent no support to the idea. Thus, these species are distinguished by four distinct characters, gathered from egg, mine, frass (colour) and larva. All four are practically of much the same value, for all four are equally constant and equally accessible to observation (Wood).

Larva.—Length 2 lines; pale greenish-yellow-grey, with the dorsal vessel slightly darker; the head is pale brown, the two posterior lobes showing through the upper surface of the second segment (Stainton). Wood, however, notes that "the larva is yellow or yellowish in colour, its head is 'blackish,' and overpowers the ganglia, which are of a paler colour." Stainton's description suggests the larva of *N. regiella*.

Cocoon.—The cocoon is somewhat mussel-shaped, of a dull, dark red colour, and rather flat—it is only slightly flossy; the pupa protrudes its anterior segments from the broad end of the cocoon previous to the appearance of the imago (Stainton).

Food-plants.—*Crataegus oxyacantha*. Sorhagen adds: *Hippophaës rhamnoides*.

Time of appearance.—The species is double-brooded, the imagines appearing in May-June and July-August, the larvæ of these broods feeding in August-October, and July respectively. Stainton bred imagines on July 13th-16th, 1852, November 11th, 1852, August 24th, 1854 (from larvæ collected August 8th, 1854), and July 6th, 1863. He also captured imagines resting on oak-trunks, on June 24th, 1851. Threlfall bred (in house) imagines from March 27th to April 3rd, 1878, from larvæ obtained October 14th, 1877, at Preston.

Localities.—Cambridge: Cambridge (Farren). Cheshire: Bowdon (Edleston). Derby: Burton (Sang). Dorset: Purbeck (Bankes), Portland, Weymouth (Richardson), Glanvilles Wootton (Dale). Dublin: Dublin (Shield), Coolock, Howth (Birchall) Edinburgh: Cramond (Logan). Gloucester: Bristol (Stainton). Hereford Woolhope (Wood). Isle of Wight: (Wing). Kent: Lewisham (Stainton), Beckenham (Elisha). Lancashire: Manchester (Stainton), Preston (Threlfall). Norfolk: Norwich (Barrett). Surrey: Mickleham (Stainton). Westmorland: Witherslack (Hodgkinson). York: Scarborough (Wilkinson), Doncaster (Warren), York (Hind)

Distribution.—France: Saone-et-Loire (Constant), St. Florent. Cher (Sand). Germany: Hanover (Sorhagen). Netherlands: common (Snellen). Scandinavia: Scania (Wallengren).

NEPTICULA DISTINGUENDA, Heinemann.

Synonymy.—Species: *Distinguenda*, Hein., "Wien. Monats.," 1862, p. 305; Hein. and Sta., "Zool.," xxi., pp. 8371-2 (1863); Hein. and Wocke, "Schmett. Deutsch.," p 751 (1877); Sorhagen, "Die Kleinschmett. Brandbg.," p. 346 (1886), Hering, "Stett. Ent. Zeit.," lii., p. 220 (1891); Wood, "Ent. Mo. Mag.," xxx., p. 96 (1894); Meyr., "Handbook," etc., pp. 720-721 (1895).

Original description.—Capillis ochraceis, antennis maris longioribus, conchula flavida; alis anterioribus angustis, olivaceo-fuscis, apice vix violaceis sub-opacis, fascia postica subrecta, albida, subnitida, ciliis apice griseis. ♂ $2\frac{1}{4}$ L, ♀ $1\frac{1}{2}$ L. Obgleich ich nur ein Pärchen von dieser Art besitze, so trage ich doch kein Bedenken, sie als neu zu beschreiben, da sie von allen andern Arten sich bestimmt unterscheidet. Sie ist sowohl der *betulicola* als auch der *glutinosae* nahe verwandt, grösser als erstere. Die Kopfhaare, Augendeckel und Nackenschöpfe, auch die Beine sind wie bei *betulicola*, aber die schwärzlichen Fühler sind bei den Männern länger, indem sie merklich über die Mitte des Vorderflügels bis an die Binde reichen, dagegen sind dieselben kürzer als bei *glutinosae*, wo sie vollkommen $\frac{2}{3}$ der Vorderflügellänge haben und noch bis hinter die Binde reichen. Der Hinterleib ist schwärzlich. Die Vorderflügel sind gestreckt, schmäler und nicht so abgerundet, wie bei *betulicola*, mehr von der Form bei *glutinosae*, mit denen sie auch in dem schwachen Glanze überinstimmen. Die Fläche ist nicht so glatt, die einzelnen Schuppen sind vielmehr deutlich unter der Loupe zu erkennen; ihre Basis ist olivenerzfarbig, ihre Spitzen dunkelbraun mit ganz schwachem bläulichen Anfluge, und lassen dem unbewaffneten Auge die Fläche einfärbig olivenbraun erscheinen. Die Binde scheint nicht ganz so weit nach aussen gerückt, wie bei *betulicola* und steht vertical; sie ist gleichfalls ziemlich schmal, gleichbreit, etwas in's Gelbliche ziehend, aber merklich schwächer glänzend. Hinter ihr ist die Fläche dunkler, mit sehr schwachem violettblauen Anfluge, der auch die Wurzel der Fransen bedeckt, während die Spitze derselben ziemlich dunkelgrau ist. Die Hinterflügel mit den Fransen grau, schwach in's Braunliche ziehend. Bei dem viel kleineren Weibe, welches ich hieher ziehe, sind die Fühler kurz, die Vorderflügel ein wenig mehr erzfarben, die Binde ist etwas breiter und desshalb der Wurzel näher scheinend. . . . . Ich habe beide Geschlechter einmal aus Birkenblättern zu gleicher Zeit gezogen, bevor ich *betulicola* und *luteella* kannte, und Raupe und Mine derzeit nicht genauer beobachtet. Im vergangenen Herbste fand ich in einem Birkenblatte eine einzelne Raupe, die von den Raupen der übrigen Birken-Nepticulen verschieden scheint, bis jetzt aber keinen Falter gegeben hat. Diese kann zu *distinguenda* gehören. Sie ist wachsgelb, die Mine gewunden, ganz von dunklem Kothe ausgefüllt (Heinemann, *Wien. Ent. Monatschrift*, vi. (1862), pp. 305-306).

IMAGO.—Head ochreous. Anterior wings 4-5 mm., narrow; olive-fuscous, the apical portion of the wing darker, slightly purplish; fascia just beyond middle of wing, vertical, rather narrow, whitish-yellow, slightly glossy; cilia very dark grey with paler apices. Posterior wings and their cilia brownish-grey.

COMPARISON OF N. DISTINGUENDA WITH N. BETULICOLA, N. GLUTINOSÆ, ETC.—*N. distinguenda* is closely allied to *N. betulicola* and also to *N. glutinosae*; it is larger than the former. The frontal tuft, eye-caps, cervical tuft, and the legs are as in *N. betulicola*, but the blackish antennæ are longer in the male, since they reach perceptibly beyond the middle of the anterior wings to the fascia, but yet they are shorter than in *N. glutinosae*, in which species they have full two-thirds of the length of the anterior wings, and reach to beyond the fascia. The abdomen is blackish. The anterior wings are elongate, narrower, and not so rounded as in *N. betulicola*, more of the form of those of *N. glutinosae*, which they also resemble in their slight glossiness. The surface is not so smooth; indeed, the individual scales may be distinctly perceived with a lens; their bases are olive-bronze, their tips dark brown, with quite a faint bluish tinge, and to the naked eye the surface appears of an unicolorous olive-brown. The fascia does not appear to be quite so posteriorly placed as in *N. betulicola*, and is vertical. It is at the same time rather narrow, of uniform width, inclining to yellowish, but perceptibly less glossy. Beyond it the surface is darker, with a very faint violet-blue tint, which also prevails at the base of the cilia, whereas their tips are rather dark grey. The posterior wings and their cilia grey, slightly inclining to brownish. *N. distinguenda* is further distinguished from *N. glutinosae* and *N. microtheriella* by the ground-colour not being so blue, especially at the tip of the wing, and by the paler, more brownish, colour of the posterior wings and their cilia. From the former it also differs by the broader and more glossy fascia, from the latter by the longer antennæ of the male and by the rather duller fascia being throughout of uniform width. *N. luteella* has the antennæ and anterior wings shorter, the tip of the latter of a bright violet-blue; the fascia is nearer the base, close beyond the middle, more inclining to luteous, and ill-defined, especially towards the costa, and not metallic. *N. turicella* has the ground-colour of the anterior wings more of an olive-grey, with a dull white, distinctly oblique, fascia, edged with dark towards the base, and posteriorly rather concave; it has also paler cilia and shorter whitish antennæ. There are specimens of *N. malella* in which the anterior wings are of the same colour as in *N. distinguenda*, but that species is readily distinguished by the more brilliant fascia being placed nearer the base, and by the distinct cilial line (Heinemann).

Egg-laying.—The egg is laid anywhere on the undersurface of a leaf (Wood).

Mine.—The mine, although small and narrow, begins coarsely; it is brown, generally much contorted, several mines being often crowded together in a leaf. The gallery is filled with brown frass, very neatly coiled, and is most constant and true to type (Wood).

Larva.—The larva is yellow in colour; the head is dark-brown; a black, square-shaped surface spot is present on the underside of the prothorax; the ventral cord is black and very distinct, forming a chain of black linear markings down the centre; the urinary cords form a pair of black lines on the dorsum of the hinder segments, and are also plainly visible. The larva mines with the venter up, and shows the dark ventral cord.

Comparison of the mines and larvæ of N. distinguenda and N. betulicola.—The mines are small and narrow, especially that of *N. distinguenda*, are generally much contorted, several often crowded together in a leaf, and begin coarsely, very differently from the slender and delicate commencement adopted by *N. lapponica* and *N. confusella*. Here the resemblance between them ends. *N. distinguenda* fills its gallery with brown frass, very neatly coiled, and is always most constant and true to type. *N. betulicola* deposits its black frass without any order, and is distinctly irregular in its practice; usually it does not much more than half fill its gallery, but not unfrequently it very nearly does so, the mine at the same time being narrowed and shorter than usual, and coming extremely near the mine of *N. luteella*. The irregularity, there can be little doubt, is dependent on the nature of the leaves, for it will be found that the latter are appreciably thinner, and their network of veinlets more open where the gallery is only half filled, than where it is more completely so. Larvæ: In *N. distinguenda* the head is dark brown, a black, square-shaped spot (skin mark) is present on the underside of segment 2; the ventral cord is black and very distinct, and the urinary tubes are also plainly visible. The larva of *N. betulicola* differs in the ventral cord and spot on segment 2, being brown instead of black, and in wanting altogether the urinary tubes (Wood).

Cocoon.—The cocoons (2) average 2·2 mm. in length, and 1·75 mm. in width. To the naked eye they are of a pale flesh colour, and most resemble, of the great number of cocoons observed, those of *N. luteella*. The flesh colour is quite maintained under the lens. In shape the cocoon is inclined to the normal "mussel"-like structure, but is much more triangular, the apex being quite pointed, one side being almost straight, the opposite side and base being slightly convex. There is no flattened lateral flange, the raised portion rising directly from the edge. The surface is uniformly rough, and covered with loose flossy silken ends. [Described June 15th, 1898, under a two-thirds lens, from cocoons sent by Dr. Wood.] Wood says that "the cocoon is spun above the ground, and is buff in colour."

Food-plant.—*Betula alba*. Hering gives "*Salix caprea*," surely an error.

Time of appearance.—The species is double-brooded, appearing in May and August, from larvæ that feed up in September-October and July respectively.

Localities.—Hereford: Tarrington (Wood). Sussex: Local (Meyrick) (probably an error).

Distribution. — Germany: Brunswick (Heinemann), Hanover (Sorhagen), Alt Damm (Hering).

NEPTICULA GLUTINOSÆ, Stainton.

Synonymy.—Species: *Glutinosae*, Sta., "Ent. Ann.," 1858, pp. 96-97; "Man.," ii., p. 436 (1859); Hein., "Wien. Monats.," 1862, p. 306; Hein. and Sta., "Zool.," xxi., pp. 8373-8374 (1863); Staud. and Wocke, "Cat.," p. 338 (1871); Nolck., "Lep. Fn. Est.," p. 775 (1871); Hein. and Wocke, "Schmett. Deutsch.," p. 751 (1877); Sand, "Cat. Lep. Auvergne," p. 201 (1879); Snellen, "De Vlinders," etc., p. 994 (1882); Sorhagen, "Die Kleinschmett. Brandbg.," p. 346 (1886); Hering, "Stett. Ent. Zeit.," lii., p. 200 (1891); Meyr., "Handbook," etc., p. 721 (1895). *Glutinosella*, Dbldy., "List.," p. 36.

Original description.—Alis anticis purpureo-fuscis, fascia subobliqua albida pone medium, apice violaceo; capillis ferrugineis. Exp. al. 2½ lin. Head ferruginous. Antennæ dark fuscous. Abdomen and legs grey. Anterior wings purple-brown, with a yellowish-white, rather oblique, fascia beyond the middle; apical portion violet; cilia grey. Posterior wings pale grey, with pale grey cilia (Stainton, *Ent. Annual*, 1858, pp. 96-97).

Imago.—Head ochreous. Anterior wings 4-5 mm.; dull silky olivaceous with a purplish tint; apex violet; beyond the middle is a narrow, rather dull, yellowish-white, somewhat oblique, transverse fascia; cilia grey. Posterior wings and cilia pale blackish-grey.

Sexual dimorphism.—The blackish antennæ in the male reach beyond the fascia, in the female beyond the middle of the costa. In the females the surface is often uniformly suffused with blue up to the fascia, either in such a way that the ground colour still remains distinctly visible, or so that the entire surface is dark blue, indeed, even blue-black, but without this colouring being very bright (Heinemann).

Comparison of N. glutinosæ with N. alnetella, N. microtheriella, etc.—The imago of *N. glutinosae* is distinguished from that of *N. alnetella* by its larger size, by the purple-brown, not golden-brown, basal portion of the anterior wings, and by the fascia hardly shining at all. The latter presents a great contrast to the extreme brilliancy of the fascia of *N. alnetella*. In *N. glutinosae* the fascia is nearly as dull as in *N. microtheriella* (Stainton). The points of difference between *N. glutinosae* and *N. microtheriella* consist in the rather larger size, the less smooth surface of the anterior wings, and their being tinged more with violet, and not with so pure a blue; also by the very narrow fascia, not so purely silvery, and less shining, and finally by the longer antennæ. Those specimens of *N. glutinosae* which have little of the violet tinge, are still more closely allied with *N. turicella*, but the latter has the frontal tuft paler, the antennæ white or silvery grey to the tips; the surface of the anterior wings is rather smoother, their tip is not so blue, more of a violet-brown, the fascia is whitish, with a faint silky lustre; it is placed rather obliquely, and generally expands on the inner margin towards the base, or this expansion is at least indicated from the fascia near the inner margin being rather broken towards the base; the dark margin on the basal side of it is more pronounced. Besides, the legs in *N. turicella* are paler, especially the anterior legs and femora are whitish-grey, whereas in *N. glutinosae* these are blackish (Heinemann).

Egg-laying.—The egg is laid on the underside of an alder leaf (Nolcken).

Mine.—The mine is serpentine, with a loose excremental track in the middle (Heinemann). In August, 1881, I obtained reddish mines tenanted by reddish larvæ in alder leaves (on bushes, in a swamp at Witherslack); these produced, in late June, 1882, imagines of *N. glutinosae* (Threlfall). Die schmale Mine verläuft in weitgedehnten, manchmal einer Blattrippe folgenden Windungen; die feine, an ihrem Ende kaum breitere Kothlinie bildet einen schwärzlichen, stellenweise in Körner zerfallenden, selten unterbrochenen Faden mit allmälig breiter werdenden hellen Rändern, deren Begrenzung aus sehr flachen kleinen Bogentheilen besteht, welche erst nahe dem Minenende grösser und mehr convex werden (Nolcken).

Larva.—The larva is yellow ("wax-yellow," Heinemann) in colour; it has a distinct grey mark on the venter of the prothorax, which enables one to distinguish it from that of *N. alnetella* before the mines have acquired their distinctive characters. Nolcken writes: "Die Raupe ist gelb mit grünlichem Darm und intensiv braunem, nach hinten stark verdunkeltem Kopfe und einem grossen viereckigen, dunkelbraunen Kehlfleck. An diesem wäre sie leicht zu erkennen und von *N. alnetella* zu trennen, derselbe scheint aber nicht bei allen Exemplaren gleich dunkel zu sein, da es mir (wie bei *N. alnetella* gesagt) nicht immer gelungen war, die Raupen beider Arten in den Minen richtig abzusondern. Die letzteren kann ich jetzt nicht vergleichen, da ich von *N. alnetella* keine sicher zu ihr gehörigen habe." The larva mines with the venter uppermost.

Cocoon.—The cocoons (8) average 3 mm. in length (one reaches 3·5 mm.) and 2 mm. in width. They vary in outline from almost circular to a form that is perhaps best described as kite-shaped (under the lens one reminds one much of a scallop shell). They are all of a dark red-brown colour, with no definite flanged rim, although the very gradual rise on the outer margin towards the higher central part gives one that impression under the naked eye. The surface is rough, with a thick coating of scattered silken ends, but no outer silken covering enveloping the inner cocoon. One is attached by many silken threads to a scrap of wood. [Described June 17th, 1898, under a two-thirds lens, from pupæ sent by Dr. Wood.] Heinemann says: "The cocoon is of a broad oval form, rather arched and with flat margins; its colour is rusty brown." Nolcken writes: "Gestalt und Farbe des Cocons ist bei dieser, sowie bei den meisten anderen Arten sehr veränderlich, meist heller oder dunkler bräunlich in sehr verschiedenen Abstufungen zum Gelben, Röthlichen oder Grünlichen; fast alle färben sich über Winter rostbraun, und da sie in den meisten Fällen nichts Charakteristisches, das Erkennen einer Art Erleichterndes bieten, so werde ich sie nur dann erwähnen, wenn mir das der Fall zu sein scheint."

Food-plant.—*Alnus glutinosa*.

Time of appearance.—The species is double-brooded, the imagines appearing in May and August, from larvæ found the preceding September and July respectively. Heinemann says the larvæ feed in July, and again in September-October. Bower obtained mines on October 6th, 1894, and October 21st, 1897, at Eltham; Sang, on October 14th, 1874, at Stanhope, and October 14th, 1878, at Wolsingham. Warren bred imagines on May 23rd, 1884, from larvæ obtained at Chippenham. Nolcken found larvæ between September 10th and 24th, at Pichtendahl. Sorhagen notes that there are often 8 or 10 mines in one leaf. Threlfall bred imagines from May 25th to June 3rd, 1881, from larvæ taken at Witherslack, September 20th, 1880.

LOCALITIES.—CAMBRIDGE: Chippenham (Farren). DORSET: Bloxworth (Cambridge). DURHAM; Darlington, Wolsingham and Stanhope (Sang). HEREFORD: Tarrington (Wood). KENT: Eltham (Bower). LANCASHIRE: Preston (Threlfall). NORFOLK: Bewsey (Barrett), K. Lynn (Atmore). SUFFOLK: Brandon (Warren). WESTMORLAND: Windermere (Hodginson), Witherslack (Threlfall). YORKS: Scarborough (Wilkinson), York (Inchbald), Harrogate (Sang).

DISTRIBUTION.—France: Nohaut, Indre (Sand). Germany: Brunswick, Wolfenbuttel (Heinemann), Hanover and Saxony (Heinemann and Wocke), Breslau (Sorhagan), Alt Damm, Friedland (Hering). Netherlands: Friesland, N. Brabant (Snellen). Russia: Pichtendahl (Nolcken), Livonia (Sorhagen).

GROUP III.—Cilia of the anterior wings with no dark divisional line, but cilia becoming gradually paler towards their tips. Anterior wings with a pale but not metallic transverse fascia; basal area of the anterior wings somewhat dull.

NEPTICULA LUTEELLA, Stainton.

SYNONYMY.—Species: *Luteella*, Sta., "Ent. Ann.," 1857, pp. 110-111; "Man.," ii., p. 434 (1859); Hein., "Wien. Monats.," 1862, p. 308; Hein. and Sta., "Zool.," xxi., p. 8375 (1863); Staud. and Wocke, "Cat.," p. 338 (1871); Nolcken, "Lep. Fn. Estl.," p. 779 (1871); Hein. and Wocke, "Schmett. Deutsch.," p. 752 (1877); Wallgrn., "Ent. Tids.," ii., p. 129 (1881); Sorhagen, "Die Kleinschmett. Brandbg.," p. 306 (1886); Hering, "Stett. Ent. Zeit.," lii., p. 220 (1891); Meyr., "Handbook," etc., p. 721 (1895).

ORIGINAL DESCRIPTION.—Alis anticis saturate olivaceis, postice violaceis, fascia pone medium recta flavida, costam saepe non attingente; capillis flavidis, brunneo-mixtis. Exp. al. 2¼ lin. Head and face yellowish, more or less mixed with brown; palpi whitish; antennæ fuscous, basal joint whitish. Anterior wings dark olive to beyond the middle; considerably beyond the middle is a nearly straight pale yellowish fascia, broadest on the inner margin, and often not reaching to the costa; the apical portion of the wing is violet, the apical cilia pale yellowish; posterior wings grey, with paler cilia. By the dull yellow non-metallic fascia on the olive-coloured wings, this may be immediately distinguished from every other known species (Stainton, *Ent. Annual*, 1857, pp. 110-111).

IMAGO.—Head yellowish. Anterior wings 4-5 mm.; dark olivaceous in colour to beyond the centre; some distance beyond middle is a nearly straight, ill-defined, pale yellowish fascia, often not reaching the costa; outer area tinged slightly with violet; cilia fuscous, with paler tips. Posterior wings and cilia pale grey.

COMPARISON OF N. LUTEELLA WITH N. GLUTINOSÆ AND N. TURICELLA.—*N. luteella* differs from *N. glutinosae*, as also from *N. turicella*, by the shorter antennæ and wings ; the larger and whiter eye-caps, the forms of the fascia, partly also by the want of the dark bordering of the fascia towards the base. Besides, *N. glutinosae* has more blue on the disc, especially beyond the fascia, and the fascia is narrow, more defined, and not expanded on the inner margin, whilst before the fascia the anterior wings are irrorated with dark violet (Heinemann).

Egg-laying.—The egg is laid on the underside of a leaf of birch (Nolcken).

Mine.—Heinemann describes the mine as being "long, slightly tortuous, generally abruptly angulated, and with a slender excremental line." Wood says that the mine is small, nearly filled with irregularly arranged frass, and is similar to that of *N. betulicola*, but, in a general way, the gallery is almost completely filled with frass in the mine of *N. luteella*, and about half-filled in that of *N. betulicola*. Wood writes : "In the typical mine of *N. luteella*, the frass is distributed without any attempt at order, and fills the narrow gallery to about three-fourths of its width, but not unfrequently late in the autumn, when the leaves have lost much of their nutritive qualities and the indigestible cellulose has increased, the frass becomes so bulky that it now almost fills the mine, and is, at the same time, deposited coil fashion, though in a slovenly tentative sort of way, as if the larva were unused to the practice."

Comparison of mines of N. luteella and N. betulicola.—It is a difficult matter to distinguish between the mines of *N. luteella* and *N. betulicola*. The relative breadth of the frass-track (about half-filling the mine in *N. betulicola*, and almost completely so in *luteella*) ought to serve to differentiate them nicely, but then, under certain conditions, each varies so in the direction of the other, that it would be rash sometimes to say to which of them a mine belonged. There are other small points of difference, but I need not particularise them, since they, too, are liable to variation, and it is not after all a very important matter to distinguish the empty mines, so long as we can recognise the full ones. Besides varying in the direction of *N. betulicola*, *N. luteella* also occasionally mimics the mine of *N. distinguenda* by a rough attempt at coiling, but so clumsy is the counterfeit that it ought never to deceive the collector (Wood).

Larva.—Heinemann describes the larva as "pale green, with darker dorsal line, and feeds in July and October, in birch leaves." Wood observes that "the larva mines with the back up, but shows neither cephalic ganglia nor ventral cord. It is yellow in colour with a pale brown head, and no other visible markings, although, out of the mine, the larva shows the urinary ducts, which are not dark enough to be seen when it is in the mine." Nolcken writes : "Die Raupe war blass honiggelb mit blass braunen Kopfe, Darm kaum in der Hinterhälfte stellenweise durchscheinend, schmutzig dunkelgrünlich braun, Keulenflecke fast nicht sichtbar." Nolcken further draws attention to the colour that Heinemann gives to the larva of this species.

Cocoon.—The cocoons (4) average 2·5 mm. long, and 1·5 mm. wide. In colour they most resemble that of the cocoons of *N. distinguenda*, being of a pale flesh-colour when fresh, but becoming darker, duller, and more ochreous when they have been exposed to the weather. The cocoon is roughly ovate in outline, with no lateral flange, but somewhat egg-shaped, although rather flattened, one end (from which the empty pupa-case projects) being rather broader than its nadir. The shape of the cocoon is largely lost by its being enveloped in a plentiful covering of long, loose flossy silken fibres. The projecting pupal skin is quite transparent, without markings, except on the mesothorax, which is shaded with dark grey. [Described under a two-thirds lens, on June 17th, 1898, from cocoons sent by Dr. Wood.] Wood says that the cocoon is "white or pale buff" in colour, so that it would appear that some are even paler in colour than those described. Heinemann calls it "small, flat and buff-coloured."

Food-plant.—*Betula alba*, preferring small bushes (Stainton).

Time of appearance.—The species is double-brooded, the imago appearing in May and August, from larvæ found in September and July respectively. Stainton bred imagines on June 2nd, 1850, and May 27th-30th, 1858, from West Wickham larvæ. He captured others on May 16th, 1848, at Lewisham, June 22nd-23rd, on Dartford Heath, and May 7th and July 7th, 1852, on oak-trunks at West Wickham. Mines with larvæ were found on October 24th, 1873, at Darlington, October 2nd, 1878, at Richmond, Yorkshire, October 14th, 1878, at Wolsingham (Sang); larvæ also were found very plentifully on one small birch-tree on the hillside above the Bridge of Allan, on August 12th, 1858 (Stainton). Nolcken found imagines on June 10th, 1862, at Rotsiküll, and larvæ, September 3rd and 8th, 1866, at Pichtendahl. Threlfall bred imagines June 1st-6th, 1879, from larvæ obtained at Witherslack, October 5th, 1878.

Localities.—Aberdeen: generally distributed, Pitcaple, etc. (Reid). Cheshire: Bowdon (Edleston). Dorset: Purbeck, Wareham (Bankes). Durham: Darlington, Wolsingham (Sang). Gloucester: Bristol (Boyd). Hereford: Tarrington (Wood). Kent: Dartford Heath, West Wickham, Lewisham (Stainton). Lancashire: Manchester (Edleston), Grange (Threlfall). Leicester: Whitwick (Sang). Somerset: Clevedon (Mason). Stirling: Bridge of Allan (Stainton). Suffolk: Brandon (Warren). Surrey: Mickleham (Stainton). Sussex: Abbott's Wood, Tilgate Forest (Fletcher). Westmorland: Witherslack (Threlfall). York: Scarborough (Wilkinson), Richmond and Harrogate (Sang), Sheffield (Doncaster), York (Hind), Doncaster (Warren).

Distribution.—Germany: north Germany (Wocke), Brunswick, Wolfenbüttel, Hanover (Heinemann). Potsdam, Breslau (Sorhagen), Pomerania (Hering). Russia: Pichtendahl, Rotsiküll (Nolcken), Livland (Sorhagen), I. of Aland (Reuter). Scandinavia: Scania (Wallengren).

NEPTICULA SORBI, Stainton.

Synonymy.—Species: *Sorbi*, Sta., "Ent. Ann.," 1861, p. 91; Staud. and Wocke, "Cat.," p. 338 (1871); Nolcken, "Lep. Fn. Estl.," p. 779 (1871); Hein. and Wocke, "Schmett. Deutsch.," p. 754 (1876); Sand, "Cat. Lep. Auvergne," p. 201 (1879); Wallgrn., "Ent. Tids.," ii., p. 128 (1881); Sorhagen, "Kleinschmett. Brandbg.," p. 307 (1886); Hering, "Stett. Ent. Zeit.," lii., p. 220 (1891); Meyr., "Handbook," etc., p. 721 (1895).

Original description.—I propose this name for the blotch-making *Nepticula* of the mountain-ash (*Sorbus aucuparia*), which has been bred rather freely by Mr. Wilkinson of Scarborough. The larva cannot be at all confounded with the larva of *N. aucupariae*, since that makes a distinct regular gallery, whilst the mine of *N. sorbi* forms a very decided blotch of irregular form. The perfect insects differ vastly, *N. aucupariae* being an unicolorous, and *N. sorbi* a fasciated species. *N. sorbi* has the most resemblance to

N. floslactella and to *N. salicis*, but the fascia is broader, perfectly straight, and not so yellowish; the anterior wings are also rather more elongate, and the basal portion is of an uniform dull grey. In the *Nat. Hist. of the Tineina*, vol. i., p. 108, in the description of *N. floslactella*, the present species is thus alluded to: "A probable third species in this section differs by the anterior wings being longer, and the pale fascia more nearly perpendicular." It is satisfactory to find that a species thus dimly indicated by the imago obtains such decided corroboration by the discovery of the larva (Stainton, *Ent. Annual*, 1861, p. 91).

IMAGO.—Head ochreous. Anterior wings 6-7 mm.; basal area dull grey; a broad, straight, pale yellowish, transverse fascia beyond the middle; apical area greyish-fuscous. Posterior wings and cilia grey.

EGG-LAYING.—The egg is laid on the underside of a leaf of *Pyrus aucuparia*, sometimes near, at other times well away from a rib.

MINE.—The mine blisters very much the upper side of the leaf, and is thus conspicuous, although it is practically invisible on the undersurface. It forms at first a very slender gallery about half an inch in length, with but few windings, the rather pale frass occupying most of the mine, although there is a slender margin on either side. The mine then forms a large blotch from 10-15 mm. in length, and from 8-12 mm. in width, in which the frass appears in some cases to show the path of the larva, in other cases to be widely scattered, probably due to the larva crossing and recrossing its earlier paths when in the mine. The blotch often absorbs the first or gallery part of the mine, and in some cases two and three larvæ finish up by forming a common blotch, in one case four larvæ have blotched the whole of one side of a leaflet. A single leaflet may contain as many as seven mines. Nolcken notes that the first part of the mine consists of a very slender gallery extended in gentle curves, the frass-line forming at first a rather strong, often interrupted, thread, which soon becomes granular, and broader, but never wholly fills the mine, appearing very faint, though edged by pale borders. The second portion of the mine suddenly widens into a large brownish blotch, varying in shape, the outline, however, always consisting of sections of a circle convex exteriorly. The exit is on the upper side of the leaf. Sorhagen describes it as "fine at first, following the margin of the leaf, then, broadening, it ends in a large round blotch with the frass in the centre."

LARVA.—The full-fed larva is from 4-5 mm. long. The body is of a pale greenish colour, almost transparent, rather more distinctly coloured on the dorsum than the venter. The head is pale brown, retractile within the prothorax, which is much smaller than the meso- and meta-thorax. The thoracic segments glassy or watery-looking, scarcely tinged with green. The prolegs specially well developed on abdominal segments 1-5. The scattered hairs transparent, glass-like. There is a distinct medio-dorsal series of purplish linear spots beneath the skin of the pro-, meso- and meta-thorax. A medio-ventral series of seven narrow diamond-shaped spots run the length of the first seven abdominal segments, the spots themselves placed at the front part of each segment, and each successive pair joined by their back and front parts respectively by a slender purplish medio-ventral line, which disappears at the incisions, the latter being more deeply tinted with green than the rest of the body. The 8th abdominal segment, which is considerably swollen, presents a pair of these spots, one on either side of the median line. These spots are not surface spots, for the shiny surface of the transparent integument is seen to be quite distinct some distance above them, and one looks through the skin at the spots. The anal flap projects considerably beyond the preceding abdominal segments, which are cut off sharply ventrally. [Described under a two-thirds lens on June 21st, 1898, from a larva sent by Mr. A. F. Griffith, from North Uist.] Nolcken notes the full-grown larva as "transparent, glassy, very pale green, frequently almost colourless; the head pale brownish-yellow."

Cocoon.—The cocoons (7) examined average 3 mm. long and 2·1 mm. wide, and are spun on upper side of a leaf of *Pyrus aucuparia*. The cocoons are roughly oval in outline, but some have one end so much wider than the other, and the narrow end so pointed, as to be almost pear-shaped. The broader end is considerably flattened, and has a slightly turned-up edge. The arched portion rises rapidly from one of the long sides and the narrow end, less rapidly from the other long side and the broader end, and reaches a considerable height at the apex, which is towards the long side, from which the ascent is most rapid. The cocoon is bright deep brown in colour, with a considerable quantity of loose flossy silk especially around the rim. [Described July 20th, under a two-thirds lens, from cocoons sent by Mr. W. H. B. Fletcher.]

Food-plant.—*Pyrus aucuparia*.

Time of appearance.—The species is single-brooded. Nolcken found larvæ from June 20th to the beginning of July, but although the cocoons were kept in a warm room no emergences took place until late spring of the following year. Bower found larvæ on June 10th, 28th, and July 13th, 1892, at Richmond, Yorkshire. Sang found them in the same locality on July 13th, 1862, June 10th, 1874, June 27th, 1874 (*teste* Gardner). Griffith sent mines containing many full-fed larvæ from North Uist on June 18th, 1898; whilst Jobson captured imagines at Torwood on May 31st, 1851. Hering strangely gives the commencement of September as the time for the larva in Pomerania, a date that suggests either a double-brood or an error on the part of the observer. Threlfall obtained imagines on May 14th, 1875, from larvæ obtained July-August, 1874, at Witherslack. He also captured imagines on the wing May 14th, 1875, at Witherslack.

Localities.—Durham (Sang). Hereford: Tarrington (Wood). Inverness: North Uist (Griffith). Lancashire: Preston, Longridge (Threlfall). Norfolk: K. Lynn (Atmore). Stirling: Torwood (Jobson). Sussex: Guestling (Bloomfield). Westmorland: Windermere (Hodgkinson), Witherslack (Threlfall). Yorks: Richmond (Bower), Scarborough (Wilkinson).

Distribution.—France: Mont Dore, Auvergne (Sand). Germany: Silesian and Hercynian mountains (Wocke), Friedland and Brunswick (Sorhagen), Hartz and Sudeten mountains (Heinemann), Alt Damm, Sandsee (Hering). Russia: Finland (Wocke), Pichtendahl (Nolcken). Scandinavia: Blekinge (Wallengren).

NEPTICULA ARGENTIPEDELLA, Zeller.

Synonymy.—Species: *Argentipedella*, Zell., "Isis," 1839, p. 215; "Linn. Ent.," iii., p. 316 (1848); Tengs., "Bidrag till Finl.," 1847, p. 152; Sta., "Sys.

Cat. Tin.," p. 29 (1849); "Ins. Brit.," p. 303 (1854); "Man.," ii., p. 435 (1859); "Nat. Hist. Tin.," vii., p. 212, pl. x., fig. 2 (1862); H.-Sch., "Sys. Bearb.," fig. 834 (1853), v., p. 353 (1855); Frey, "Die Tineen," etc., p. 386 (1856); "Linn. Ent.," xi., p. 421 (1857); Heyden, "Stett. Ent. Zeit.," 1861, p. 41; Staud. and Wocke, "Cat.," p. 338 (1871); Nolck., "Lep. Fn. Estl.," p. 780 (1871); Hein. and Wocke, "Schmett. Deutsch.," p. 754 (1877); Sand, "Cat. Lep. Auvergne," p. 201 (1879); Erschoff, "Trudy Russ. Ent. Soc.," xii., p. 221 (1881); Bang-Haas, "N. H. Tids.," xiii., p. 217 (1881); Wallgrn., "Ent. Tids.," ii., pp. 128-9 (1881); Peyer., "Cat. Lep. Alsace," 2nd Ed., ii., p. 164 (1882); Snellen, "De Vlinders," p. 996 (1882); Sorhagen, "Die Kleinschmett. Brandbg.," p. 307 (1886); Hering, "Stett. Ent. Zeit.," lii., p. 221 (1891); Meyr., "Handbook," etc., p. 731 (1895).

Original description.—7. *Argentipedella*, Z. (*mucidella*, Tr. ?). Grösse der vorigen (*N. lemniscella*); die Vorderflügel zugerundet, etwas glänzend, braun, nach hinten violett; eine schräge, weissliche Binde hinter der Mitte; die Kopfhaare schwarz oder rostgelb; die Augendeckel weisslich. 5 Ex. bei Glogau und am Spitzberge im Mai und Juni in Gebüsch (Zeller, *Isis*, 1839, p. 215). This was followed (*Linn. Ent.*, iii., p. 316) by the following diagnosis: "Alis anterioribus fuscis, violaceo-nitidulis, fascia paulo post medium alba; capillis ♂ nigris, ♀ ferrugineis; conchula antennarum exalbida majore."

Imago.—Head dark fuscous (female reddish). Anterior wings 6-7 mm.; black, with a violet gloss towards the apex; a rather broad, oblique, dull whitish transverse fascia, somewhat attenuated or interrupted in the centre; cilia grey, with tips whitish. Posterior wings grey, with paler cilia.

Egg-laying.—The egg is laid on the undersurface of a birch leaf, and very frequently near one of the lateral ribs.

Mine.—Stainton says: "The mine is irregular in form, but the commencement is always of a peculiar dark-brown colour and remains conspicuous, the remainder of the blotch being of a pale greenish-brown. The excrement is scattered irregularly in the mine, and does not form a definite track." Heyden writes: "The larva makes a more or less rounded black-brown blotch, with paler edges. The central portion, filled up with the excrement of the larva, serves for its abode, and the pale margins are the places where it feeds on the parenchyma. Sometimes a number of these blotch-mines may be found in one leaf. I have often found the mines in countless numbers." Wood notes: "The blotch made by this species is peculiar, inasmuch as it exhibits no sign of having originated from a gallery like the blotches made by other species. It is more or less circular in shape, with a central black spot, under which the larva lies curled up a large part of its time, only coming out to eat at intervals, and is, in consequence, a long time feeding up, in all which particulars the habits are rather those of a *Tischeria* than of a *Nepticula*."

Larva.—Length 2½ lines. Pale greenish in colour, the dorsal vessel bright green. The head and prothorax light brown, the mouth and two lines receding from it reddish-brown. There is a medio-ventral row of dark reddish oblong spots (Stainton). The larva appears to be a very sluggish feeder; it is seldom to be seen feeding and usually lies hidden beneath the dark central portion of the mine. It mines with the venter uppermost (Wood). Heyden describes the larva as follows: "Raupe glänzend, glatt, weisslichgrün, mit einer Längsreihe schwarzer Fleckchen auf der Bauchseite. Kopf honiggelb mit etwas dunkleren Rändern. Nackenschild mit zweilappigem braunem Fleck." [Also described in comparison with *N. woolhopiella*, *vide*, p. 292.]

Cocoon.—Stainton says that the cocoon is dark green in colour, and spun on the surface of the ground. Heyden says: "The larva quits its mine when full-fed, and spins its cocoon in some convenient spot; sometimes many cocoons may be found close together. The cocoon is oval, slightly arched, scalloped, and pale brown in colour."

Food-plant.—*Betula alba*.

Time of appearance.—The species seems to be single-brooded, appearing in May and June, from larvæ feeding the previous September-November. Mann's record of finding larvæ in May, 1853, on sloe bushes, at the Pulverthurm, can be entirely disregarded. Nolcken found imagines in abundance on warm, calm days, at Pichtendahl, from May 19th-June 24th, and remarks that the larvæ prefer the leaves of the highest branches. Evans reports the imagines as abundant on June 10th, 1895, at Boghall, and June 20th, 1895, near Kirknewton, flying among grass. Stainton bred the perfect insect on May 28th, 1856, June 9th, 1857, and Atmore says that it usually occurs at King's Lynn, late in May. Bower obtained larvæ on September 25th, 1891, in Teesdale, October 11th, 1891, at Chislehurst, October 11th, 1892, at Darenth, October 25th, 1892, at Eltham, and October 5th, 1893, at Bexley. Stainton captured imagines on May 25th, 1856, and June 2nd, 1857, at West Wickham, May 17th, 1868, at Lewisham, and on July 15th, 1850, at Dunoon, when imagines were beaten from a sandbank. Laing also took imagines on June 19th, 1884, and June 17th, 1885, near Shinfall. Threlfall bred imagines in May, from larvæ found in September; he also captured imagines on May 14th, 1875, on the wing, at Witherslack. Atmore captured imagines on May 30th, 1898, at King's Lynn, and Zeller records imagines at Glogau, May 17th-25th.

Localities.—Argyleshire: Dunoon (Stainton). Cambridge: Chippenham (Farren). Cheshire: Bowdon (Edleston). Derby: Burton (Sang). Dorset: Purbeck (Bankes), Glanvilles Wootton and Knighton Heath (Dale), Bloxworth (Cambridge). Dublin: Howth (Birchall). Durham: Teesdale (Bower), Darlington (Sang). Edinburgh: Ravelrig Bog (Logan). Gloucester: Bristol (Stainton). Hereford: Tarrington (Wood), Leominster (Hutchinson). Kent: Dartford Heath, West Wickham (Stainton), Chislehurst, Darenth, Eltham and Bexley (Bower). Lanark: Cadder Wilderness, Langside (King). Lancashire: Manchester (Stainton), Grange (Threlfall), Preston (Hodgkinson). Leicester: Whitwick (Sang). Midlothian: Boghall, Kirknewton (Evans). Moray: Forres (Salvage *teste* Fletcher). Norfolk: King's Lynn (Atmore), Myntlyn, Bawsey (Barrett). Stirling: Milngavie (King). Suffolk: Leiston (Walsingham). Surrey: Mickleham (Stainton). Haslemere (Barrett). Sussex: Lewes (Stainton), Abbott's Wood, nr. Amberley (Fletcher). ? Sutherland: nr. Shinfall (Laing). Westmorland: Witherslack (Hodgkinson). Yorks: Scarborough (Wilkinson), York (Stainton), Doncaster (Corbett), Harrogate and Richmond (Sang), Huddersfield (Inchbald).

Distribution.—Austria: ? Tersatto, and ? the Pulverthurm (Mann), Vienna (Metzner). Denmark: North-east Zealand (Bang-Haas). France: Sologne, La Brande, Nohaut, Indre (Sand). Finland: Helsingfors, Borgå (Tengström). Germany: Generally distributed (Hein. and Wocke), Berlin (Bouché), Havelland, Potsdam, Hamburg, Halle (Sorhagen), Glogau and Warmbrunn (Zeller), Frankfort-on-the-Main, Wiesbaden, Taunus Mountains (Heyden), Ratisbon (Herrich-Schäffer), Freiburg (Reutti), Brunswick (Heinemann), Saverne, Alsace (Peyerimhoft), Liebeseele nr. Misdroy, Dunzig-Aufschuttüng, Güterbahnhof, Alt Damm (Hering), Frankfort (Durrant). Netherlands: Gravenhage, South Holland (Snellen). Russia: S. Petersburg (Erschoff), Pichtendahl (Nolcken), Kokenhusen (Lienig). Scandinavia: S. and Central Sweden (Wallengren). Switzerland: Zürich (Zeller).

NEPTICULA WOOLHOPIELLA, Stainton.

SYNONYMY.—Species: *Woolhopiella*, Sta., "Ent. Mo. Mag.," xxiv., p. 62 (1887). *Argentipedella*, Meyrick, "Handbook," etc., p. 721, in part (1895).

ORIGINAL DESCRIPTION.—Smaller than *N. argentipedella*, with the apical half of the wing blacker, the fascia brighter (that is, more silvery), and rather more oblique on its inner edge; in *N. argentipedella*, the fascia generally expands a little towards the base on the inner margin of the wing, which gives the inner edge of the fascia a rather concave appearance; in the new birch-feeder the inner edge of the fascia has not this concave appearance, it being nearly straight, though oblique (Stainton, *Ent. Mo. Magazine*, xxiv., p. 62).

IMAGO.—Head dark fuscous, white eye-caps prominent. Anterior wings 5 mm. in expanse; blackish-fuscous; a bright, white, oblique, transverse fascia near the centre; apex and costal fringes blackish; cilia uniformly blackish-grey. Posterior wings and cilia pale grey.

COMPARISON OF N. WOOLHOPIELLA AND N. ARGENTIPEDELLA.—*N. woolhopiella* looks much like a small edition of *N. argentipedella*, but the females have not the reddish head of that sex of the latter species. Meyrick refers *N. woolhopiella* to *N. argentipedella*, but gives no reason for doing so. He appears to be entirely wrong in this. Wood writes: "The imagines of these species are much alike, except in the matter of size (*N. woolhopiella* being a much smaller insect), but in mine, larva and habits they are distinct enough. Both lay their eggs on the underside of a leaf. The mine of *N. argentipedella* is more or less circular, with a black opaque spot in the centre. That of *N. woolhopiella* roughly triangular, with a small knot of convolutions in one corner, very similar to the bundle of convolutions from which the mine of *N. continuella* starts. Both mines form blotches. The larva of *N. argentipedella* lives in its mine venter up. In form it is unusually flat, legs very small, the thoracic segments large and heavy, something after the fashion of a *Micropteryx* larva; colour whitish, head brown, intestinal canal green; cephalic ganglia and nerve-cord distinct brown. The larva of *N. woolhopiella* is yellow. The larva of *N. woolhopiella* is to be found in August and September, that of *N. argentipedella* in September and October, or as long as the leaves hang on the trees. *N. argentipedella* is a remarkably slow feeder. It spends a great deal of time under the black canopy, in the middle of its mine, doing nothing, just like a *Tischeria*. Probably its shape, so peculiar for a Nepticulid larva, is connected with its habit of moving freely about its mine" (*in litt.*, June 3rd, 1898).

EGG-LAYING.—The egg is laid on the underside of a leaf of birch.

MINE.—The first part of the mine forms a gallery which is short and twisting, but it becomes hidden away in a corner of the blotch that is finally formed. The completed mine really forms a blotch, roughly triangular in shape, and usually placed in the body of the leaf, occasionally, however, on the edge; in the former case it bears a general likeness to the mine of *N. subbimaculella*, and in the latter to that of *N. pulverosella* in wild apple. A tiny brown spot, consisting of a knot of convolutions occupies one corner of the blotch and indicates the point from which the mine started, and this tiny knot occupies the whole life of the larva from the time of hatching until the assumption of the last skin (Wood).

LARVA.—Stainton describes the larva of *N. woolhopiella* as "very pale green," whereas it is yellow—indeed, a deep yellow—the greater part of its life, but becoming paler when practically adult; it borrows something of a greenish tinge from its surroundings, though its true colour is still yellow, as can be ascertained by removing it from the mine. The larva of this species feeds up much more quickly than that of *N. argentipedella*, and is always to be found with its head at the margin of the mine, either actually eating or just ready to eat.

COCOON.—The cocoon, which is spun up beneath the soil, is very roughly oval in outline, flattened, but raised considerably in the central area of the upper part, so that the base bends considerably beyond the somewhat flattened dome that surmounts it. The cocoon is made of closely woven black silk, the outside in contact with several small pieces of earth. The inside of the cocoon is rather smooth, and very shiny, but of the same colour and texture as the outer part. [Described under a two-thirds lens, June 7th, 1898, from cocoons sent by Dr. Wood.] Wood supplied the larvæ with earth in which to pupate. The pot containing them was kept out of doors, and the treatment proved most successful. Length of cocoon 2·75 mm., breadth 2 mm.

FOOD-PLANT.—*Betula alba.*

TIME OF APPEARANCE.—The species is single-brooded, imagines appearing in May-June from larvæ that feed up in August and September. Threlfall bred imagines in May and June, 1888, from larvæ obtained on July 25th and in August, 1887, at Witherslack.

LOCALITIES.—HEREFORD: Woolhope (Wood). LANCASHIRE: Grange (Threlfall). WESTMORLAND: Arnside (Hodgkinson), Witherslack (Threlfall).

NEPTICULA LAPPONICA, Wocke.

SYNONYMY.—Species: *Lapponica*, Wocke, "Stett. Ent. Zeit.," 1862, p. 251; Staud. and Wocke, "Cat.," p. 339 (1871); Wallgrn., "Ent. Tids.," ii., p. 130 (1881); Wood, "Ent. Mo. Mag.," xxix., p. 272 (1893); Ibid., xxx., p. 95 (1894); Meyr., "Handbook," etc., p. 724 (1895). *Lapponicella*, Porritt, "List of Yorks. Lep.," p. 170 (1886).

ORIGINAL DESCRIPTION.—Capillis sordide ferrugineis, antennarum conchula parva flavescente-albida. Alis anter. griseis obsolete rubescenti-violaceo-micantibus, apice leviter violaceo-tincto, fascia obliqua postica exalbida, ciliis griseis. Exp. alar. 6½-7 mm. Mit keiner verwandten Art zu verwechseln, am ähnlichsten noch blassen Exemplaren von *N. salicis*, doch durch bedeutendere Grösse, andere Färbung der Kopfhaare etc. leicht zu unterscheiden. In der Grösse übertrifft sie um ein Geringes die *N. argentipedella*, ihre Gestalt ist aber weit schlanker, der Körper dünn, die Flügel gestreckt und ziemlich schmal. Kopfhaar schmutzig rostgelb, nach hinten meist etwas heller als vorn. Fühler hellgelbgrau, nach der Spitze zu am dunkelsten, an der Basis gelblich, die Muschel klein, gelblichweiss. Rücken gelblichgrau, grünlich oder röthlich schimmernd. Beine gelbgrau glänzend. Hinterleib des ♂ einfarbig dunkel gelbgrau, der des ♀ heller, oben mit eingemengten einzelnen opalisirenden Schuppen, unten seidenglänzend. Vorderflügel auf gelblichem Grunde grob dunkelgelbgrau beschuppt, von der Seite betrachtet röthlich, in der Spitze violett schimmernd. Am Anfang des letzten Flügeldrittels liegt eine grade, ziemlich breite Querbinde von blassgelblicher Farbe, ihre Richtung ist etwas schräg, indem ihr Vorderrandende mehr nach innen liegt, als das dicht am Hinterwinkel befindliche Innenrandende, bei den meisten Exemplaren ist diese Binde überall von gleicher Breite, bei einigen aber an den Enden etwas verdickt. Die Franzen der Vorderflügel, sowie die Hinterflügel sind licht gelblichgrau. Auf der Unterseite sind die Vorderflügel fein schuppig, gelbgrau mit röthlichgelbem oder violettem Schimmer, die Franzen und Hinterflügel wie auf der Oberseite. . . . Als ich Anfang August nach der Raupe suchte, kam ich leider zu spät, da ich an den Birkenblättern nur bereits verlassene Minen antraf. Diese Minen, die ich mit grosser Wahrscheinlichkeit als hierher gehörig betrachte, sind von bedeutender Länge, beginnen auf der Oberseite des Blattes über dem unten festgeleimten Ei in einer feinen Linie, die gewöhnlich, dem Laufe einer Rippe folgend, sich rasch verbreitert und mit einem grossen, unregelmässig ovalen, hellgrünen, exkrementlosen Fleck endet. Im Anfang ist die Mine vollständig mit Excrementen erfüllt, weiterhin bilden dieselben in der Mitte des Ganges eine schmale braune Linie. Aehnliche Minen bemerkte ich auch auf Birkengesträuch in der Nähe von Fogstuen auf dem Dovre, aber auch diese waren verlassen (Wocke, "Reise nach Finmarken," *Stett. Ent. Zeit.*, 1862, pp. 251-253).

Imago.—Head reddish. Anterior wings 6-7 mm.; yellowish-grey, shiny, with a reddish tinge; apex slightly violet; an oblique, rather broad, yellowish-white, transverse fascia, beyond the middle: cilia pale yellowish-grey, darker at base. Posterior wings and cilia pale yellowish-grey.

Comparison of N. lapponica with N. sorbi.—*N. lapponica* is closely allied to *N. sorbi*, but has the fascia less oblique, more yellow, and generally broader (Threlfall).

Egg-laying.—The eggs are laid on the upper side of a leaf (Wocke).

Mine.—The larva makes a long gallery in a birch leaf, and is markedly angular (never contorted), going off sharply from one point to another. The commencement of the mine is straight, and very fine. In the first portion of the mine (corresponding to the first two skins of the larva), the frass is of the typical concretionary character and completely fills the mine; in the second part it is coiled, but rather obscurely, owing to a tendency that the pellets still have to run together; in the third portion the frass, which has hitherto filled the mine, is suddenly collected into the centre, leaving a wide margin on each side, and, at the same time, the colour, which up to this point has been green, changes to black (Wood).

Larva.—The larva is yellow in colour, the cephalic ganglia brown and distinct, the head black. No trace of the ventral cord is discoverable whilst the larva remains *in situ*, but it becomes visible when the larva is removed from its mine, and is faint brown in colour. The larva mines with the back up and shows distinctly the brown cephalic ganglia (Wood). Threlfall notes the larva as "greenish-yellow" in colour.

Comparison of the mines and larvæ of N. lapponica and N. confusella.—The mines of both are long galleries of moderate width, whose usual course is to follow a rib for some distance, and then to turn off at a tangent till another is reached, which, in its turn, is pursued; but whether the ribs be taken as a guide or not, the mine is never contorted, and this holds good even with their very commencement, which, beginning in a delicate and hairlike manner, stretches straight away at once from the site of the egg. So far, and in a general view, the mines are precisely alike, but in the two portions which answer to the first three skins of the larvæ, and which, from their apparent insignificance are apt to be overlooked, most excellent and easily appreciable characters may be gathered. In the case of *N. lapponica*, the frass completely fills these two portions of the mine, while it is coiled in the second of them, its colour in both is green, thereby offering a striking contrast to the third or main portion of the mine, in which the frass is black, and collected into a narrow thread. On the other hand, the frass in *N. confusella* is black throughout, there is no coiling in the middle portion, and a free margin borders its track in all three portions, so that the character of the mine is uniform from beginning to end. . . . . . The larva of *N. lapponica* is yellow, with the cephalic ganglia brown and distinct, yet at the same time less conspicuous than the head; that of *N. confusella* is greenish-white, the head very pale brown, the cephalic ganglia dark and distinct, and markedly more conspicuous than the head. The larva of *N. lapponica* feeds in June, that of *N. confusella* a little later, in July (Wood).

Cocoon.—The cocoons examined (5) average about 2·4 mm. in length and 1·5 mm. in width. They are oval in outline with one end rather broader than its nadir, in fact, it belongs to that shaped cocoon which we have elsewhere designated as almond-shaped. The cocoon, however, is comparatively thick, being considerably domed from rim to apex. It is of a deep reddish- or purplish-brown colour, the silk matted into blackish threads on the surface, and holding pieces of earth and sand, the loose fibres round the rim being united into projecting cables, as it were, by which the cocoon has been attached. The rim is not at all well developed, but is conspicuous from being orange instead of purplish-brown in colour. The empty pupa-case is transparent, shaded somewhat with pale grey, and projects from beneath the rim. [Described July 12th, 1896, under a two-thirds lens, from cocoons sent by Dr. Wood.] The cocoon varies from dark brown to almost black, and is usually placed under the soil (Wood).

Food-plant.—*Betula alba*.

Time of appearance.—The species is undoubtedly partially double-brooded, the second brood of imagines being a very small one. Atmore says that it is very early on the wing, imagines having been obtained as early as April 16th, and Wocke obtained imagines at Bossekop (lat. 69° 30′ N.) from May 28th-June 14th, 1861, flying about *Betula alba*. Sang notes imagines on June 2nd, 1879, and August 23rd, 1873, at High Force; Shuttleworth records imagines amongst birch, at Witherslack, on May 13th, 1882, whilst Bower found imagines on June 2nd and 3rd, 1891, at Teesdale, and Evans, June 6th, 1895, at Boghall, and June 20th, 1895, at Midcalder. Wood records that the larva feeds in June, although occasionally a few mines may be picked up late in autumn; but Bower found larvæ at Teesdale, from August 17th-23rd, 1892, and Threlfall bred the imagines from May 20th-25th, from larvæ found between October 1st-20th, 1878, at Grange; he also notes larvæ as early as July 15th, 1878, at Witherslack.

Localities.—Durham: High Force (Sang), Teesdale (Bower). Edinburgh: Boghall (Evans). Hereford: Tarrington (Wood). Lancashire: Grange, ? Preston (Threlfall). Midlothian: Midcalder (Evans). Norfolk: King's Lynn, common (Atmore). Sussex: Brighton (Vine), Abbott's Wood (Fletcher). Westmorland: Windermere (Hodgkinson), Witherslack (Shuttleworth). Yorkshire: Scarborough (Wilkinson *teste* Shuttleworth).

Distribution.—Russia: Alten in Lapland (Staudinger *teste* Durrant), Finland (Staudinger and Wocke). Scandinavia: Bossekop, Finmark (Wocke).

NEPTICULA CONFUSELLA, Walsm. and Wood.

Synonymy.—*Confusella*, Walsingham and Wood, "Ent. Mo. Mag.," xxx., pp. 272-273 (1894); Meyrick, "Handbook," etc., p. 724 (1895).

Original description.—Antennæ in the ♂ long (reaching to the fascia when laid back at rest), shorter in the ♀, cinereous; eyecaps whitish. Head amber-yellow. Thorax brownish-cinereous. Forewings brownish-cinereous, with a slight purplish lustre in a strong light, especially towards the apex; a broad, ill-defined, whitish fascia at two-thirds of the wing length, scarcely oblique, but slightly inclining outwards from the costal margin to before the anal angle, somewhat narrower in the middle than on the costal and dorsal margins; cilia brownish-grey, paler on their outer half, and about the anal angle. Hind-wings greyish, cilia with a slightly browner tinge. Abdomen brownish-cinereous. Posterior legs pale cinereous. Exp. alar. 4·5-6 mm. Emerges beginning of May (in confinement)" (Walsingham, *Ent. Mo. Mag.*, xxx., pp. 272-273). A life-history by Wood follows.

Imago.—Head yellowish. Anterior wings 4·5-6 mm.; brownish-grey, with a slight purplish tint towards the apex; a broad, ill-defined whitish fascia, slightly inclined outwards, beyond the middle; cilia brownish-grey, paler on their outer half. Posterior wings and cilia greyish. [This and the preceding species may belong to Group V.]

Comparison of N. confusella with N. lapponica.—The species are very close in the imaginal state, but *N. confusella* may be distinguished by its darker colour and more distinct fascia. The larvæ are, however, distinct enough. Thus, instead of greenish-white, the larva of *N. lapponica* is yellow, with a black head and black prothoracic plate, the latter much obscuring the brown cephalic ganglia. The mine, also, of *N. lapponica* is quite distinct; in the early part the frass is green, coiled, and quite fills the bore; afterwards, and concurrently with the last moult, it gets collected into a central thread, and changes from green to black, becoming from this point a *facsimile* of the mine of the other (Wood).

Egg-laying.—The egg is laid on the underside of a birch leaf.

Mine.—The mine is large and angular, and consists of a long gallery of moderate width, whose usual course is to follow a rib for some distance, and then to turn off at a tangent till another is reached, which in its turn is pursued; the mine is never contorted, and even at its very commencement the delicate hair-like gallery stretches straight away at once from the site of the egg. The frass is black, and forms a central thread throughout, there is no coiling in the middle portion of the mine, and a free margin borders its track in all three portions, so that the character of the mine is uniform from beginning to end.

Larva.—The larva is greenish-white in colour, the head very pale brown; immediately behind the latter is a pair of dark conspicuous spots (the cephalic ganglia). As it burrows in the leaves of birch with the back uppermost, it shows distinctly the cephalic ganglia, which are dark, and markedly more conspicuous than the head. No trace of the ventral cord is distinguishable so long as the larva remains *in situ*.

Cocoon.—The cocoons examined (6) average about 2·5 mm. in length and 1·6 mm. in width. They are very irregular in shape, although some are moderately oval in outline, and domed towards a median line that runs longitudinally along the apex. Their colour is deep dirty-brown. There is no very clearly defined rim, although a quantity of loose silken fibres project from its edges. The upper surface of the cocoon is much reticulated with dark brown, and a number of loose fibres of flossy silk project irregularly all over the surface. [Described July 12th, 1898, under a two-thirds lens, from cocoons sent by Dr. Wood.] The cocoon forms an imperfect oval, being wider at the mouth than at the opposite end; smooth and dark-brown in colour; placed on, or just beneath, the surface of the soil (Wood).

Food-plant.—Birch (*Betula alba*).

Time of appearance. — The species is single-brooded, the larva occurring at the end of June and well on into July, the imago emerging early in the following May. The larva of this species just begins to appear as that of *N. lapponica* is going over. Wood notes that eight specimens emerged May 1st-5th, 1894.

Localities.—Dorset: Purbeck (Bankes). Hereford: Tarrington (Wood). Norfolk: Merton (Walsingham). Sussex: Brighton (Vine).

NEPTICULA TURICELLA, H.-Sch. and N. BASALELLA, H.-Sch.

We have in Britain two beech-feeding Nepticulid species, known as *Nepticula tityrella* and *N. fulgens*. On the continent the same two species are respectively known as *N. turicella* and *N. tityrella*. *N. turicella* (our *N. tityrella*) is the species with a non-metallic transverse fascia to the fore-wings; *N. tityrella* (our *N. fulgens*) is the species with a metallic fascia. The *N. tityrella* of our collections is, however, not the *N. tityrella* of Stainton, which is synonymous with *N. fulgens*, Sta., *i.e.*, *N. tityrella*, Sta. and *N. fulgens*, Sta., both refer to the species with a metallic fascia, the species with a non-metallic fascia (erroneously named in collections *N. tityrella*) never having been described in Britain. Durrant determines *N. basalella*, H.-Sch., as the oldest name for the species with a metallic fascia, so that the two species stand as: (1) *N. turicella*, H.-Sch. (2) *N. basalella*, H.-Sch. There can be no doubt that *N. tityrella*, Sta. = *N. fulgens*, Sta., for, besides the evidence of the description of the imagines, there is the evidence of the mine. Wood notes (*E.M.M.*, xxix., p. 273) that: (1) The second portion of the mine of *N. fulgens*, Sta., is characterised by unmistakeable coiling. (2) The mine of *N. tityrella* (coll. Brit.) has never the slightest indication of coiling in any part of its course. Stainton notes (*Nat. Hist. Tin.*, i., p. 148): "The frass in the mine of *N. tityrella* . . . . for some distance fills the whole width of the mine, being placed in a series of little arcs of circles." Therefore, *tityrella*, Sta. = *fulgens*, Sta., Wood = *basalella*, H.-Sch. (*teste* Durrant). The *N. tityrella* of Wood (and our collections) is *N. turicella*, H.-Sch. = *N. turicensis*, Frey.

NEPTICULA TURICELLA, Herrich-Schäffer.

Synonymy.—Species: *Turicella*, H.-Sch., "Sys. Bearb.," v., p. 355, no. 1118 (1855); Hein., "Wien. Ent. Monats.," vi., p. 309 (1862); Hein. and Sta., "Zool.," xxi., p. 8375 (1863); Staud. and Wocke, "Cat.," p. 338, no. 3038 (1871); Hein. and Wocke, "Schmett. Deutsch.," p. 753 (1877); Sand, "Cat. Lep. Auv.," p. 201 (1879); Bang-Haas, "N. H. Tidsk.," p. 257 (1881); Peyer., "Cat. Lep. Als.," 2nd Ed., ii., p. 164 (1882); Snellen, "De Vlinders," etc., p. 993 (1882); Sorhagen, "Die Kleinschmett. Brandbg.," p. 307 (1886). *Ignobiliella*, H.-Sch., "Sys. Bearb.," pl. 104, fig. 816 (1853). *Turicensis*, Frey, "Die Tineen," etc., p. 391 (1856); "Linn. Ent.," xi., p. 413 (1857). *Tityrella*, Wood, "Ent. Mo. Mag.," xxix., p. 273 (1893); Ibid., xxx., p. 49 (1894).

Original description.—*Turicella* (— *ensis*), Frey. *Ignobiliella*, Sppl., 816. Binde zu breit, zu wenig schräg, Farbe der Wurzelhälfte nicht gelb genug, die Wurzelhälfte der Franzen zu scharf abgeschnitten. Etwas kleiner, resp. mit kürzeren Flügeln als *N. huebnerella*, das Gelb des Kopfes matter, die Augendeckel nicht so glänzend weiss, daher beide nicht so von einander abstechend. Die Vorderflügel an der Wurzelhälfte bleich messinggelb, desshalb das weisse Band nicht so deutlich, es scheint mehr gegen den Afterwinkel gerichtet. Die Flügelspitze erzfarbig olivenbraun, ohne Violett, die Franzen um die Spitze herum ihrer Länge nach weisslich. Aus Braunschweig als *N. argentipedella* und *N. hemargyrella* von H. v. Heinemann; aus der Schweiz von H. Prof. Frey (Herrich-Schäffer, *Systematische Bearbeitung der Schmett. von Europa*, v., p. 355).

[Heinemann supplements this description, from bred individuals, as follows: "The frontal tuft pale ochreous, the cervical tuft whitish; the small eyecaps and antennæ whitish; the latter in ♂ nearly two-thirds length of fore-wings, in ♀ nearly one-half. Abdomen and hind-legs blackish-grey, middle legs and tarsi whitish; anterior legs pale grey. Anterior wings olivaceous inclining to grey, sometimes nearly olive-black, not 'brownish-yellow,' as Frey says, nor 'pale brassy-yellow,' as Herrich-Schäffer writes; the surface finely scaled, not polished, and not very shiny; the fascia not broad, rather oblique, and perceptibly beyond the middle, its posterior edge somewhat concave, so that on the margins it appears broader, especially on inner margin; its colour whitish with a dull silky gloss, bordered towards base by a dark-brown stripe having a faint violet gloss; the entire tip of fore-wing, and base of cilia of the same colour. Cilia darker grey in middle, paler grey at tips; the posterior wings and their cilia grey."]

Imago.—Head ochreous. Anterior wings 5-6 mm.; yellowish-fuscous at the base; a whitish somewhat oblique fascia beyond the middle, edged internally with dark fuscous; apex dark fuscous, tinged with violet; cilia greyish-white, with paler tips. Posterior wings and cilia pale grey.

Egg-laying.—The egg of this species is laid on the underside of a beech-leaf, among the tufts of hair that grow in the angles of the midrib, and affords an excellent example of the precision that some species display in the choice of a position for the egg (Wood).

Mine.—The mine of *N. turicella* is, as a rule, smaller than that of *N. basalella*; that of the former is a vermiform gallery, usually confined to the space between two adjacent ribs of a leaf, and that of the latter a more or less straight gallery, which pays little regard to boundaries, yet, occasionally, one will adopt the pattern of the other. The absence of the coiled frass in the middle part of the mine of *N. turicella* always forms a good point of separation from that of *N. basalella*, in the middle part of which the frass is coiled (Wood). Heinemann, however, says: "The mine of *N. turicella* is like that of *N. tityrella* (*basalella*), but long, and its tortuosities are not so close to one another," whilst Sorhagen states that "the mine is long, irregularly curved, longer than that of *N. tityrella*, and less twisted," probably following Heinemann.

Larva.—The head is black, especially its posterior lobes; the cephalic ganglia also are black, and look like a part of the head; the ventral nerve-cord, also, is fairly visible when the leaf is turned over (Wood). The larva is yellow in colour (Threlfall).

Cocoon.—The cocoon is very pale yellowish in colour (some almost whitish) surrounded and entirely covered by a large amount of loose flossy silk of the same colour. It is almost a perfect oval in outline, and although flattened, is much less so than the cocoons of many other species. [Described June 7th, 1898, from cocoons sent by Dr. Wood.] The cocoon is woolly, and white in colour (Wood). Heinemann writes: "The cocoon is longish, much arched, and of an ochreous-yellow colour." Length of cocoon 2·4 mm., width 1·4 mm.

Food-plant.—*Fagus sylvatica.*

Time of appearance.—The species is double-brooded, the imagines appearing in May and July-August, from larvæ feeding in October and June-July respectively. Imagines were captured at Arnhem, on May 13th, 1873, by De Rooy. From larvæ obtained in October, in Hanover, imagines were bred in May. Farren breeds the imagines in May and June, from larvæ obtained September-October, at Cambridge. Bower captured imagines at Bexley, May 20th, 1887. Threlfall bred imagines from April 11th-20th, 1878, from larvæ captured at Grange, October 5th, 1877.

Localities.—Doubtful.—Cambridge: nr. Cambridge, on the Gogs, common (Farren). Cheshire: Bowdon (Edleston). Derby: Branstone (Sang). Dorset: Weymouth (Richardson), Bloxworth (Cambridge), Purbeck (Bankes). Hereford: Tarrington (Wood). Kent: Bexley (Bower). Lancashire: Grange, Preston (Threlfall). Norfolk: Middleton (Barrett), King's Lynn (Atmore). Somerset: Clevedon (Mason). Suffolk: Great Glenham (Bloomfield). Surrey: Box Hill (Stainton). Sussex: common—Worthing, Brighton, Abbott's Wood (Fletcher), Guestling (Bloomfield). Westmorland: Windermere (Hodgkinson). Yorks: Doncaster, abundant (Corbett), Richmond (Sang), Scarborough (Stainton), York (Hind).

Distribution.—? Denmark: North Zealand (Bang-Haas). France: Auvergne, Creuse, Nohaut (Sand). Germany: generally distributed (Heinemann and Wocke), Brunswick (Heinemann), Alsace (Peyerimhoff), Hanover (Hoffmann), Glogau (Zeller *teste* Heinemann), Potsdam, Stettin (Sorhagen). Netherlands: nowhere rare where its food-plant occurs (Snellen), Arnhem (Rooy). Switzerland: nr. Zürich (Frey), Bremgarten (Boll).

Group IV.—Cilia of the anterior wings with a distinct or indicated divisional line, beyond which they are abruptly paler. The anterior wings with a distinct metallic fascia at or beyond the middle.

NEPTICULA BASALELLA, Herrich-Schäffer.

Synonymy.—Species: *Basalella*, H.-Sch., "Sys. Bearb.," pl. cv., fig. 831, *e* (1853), text, vol. v., p. 354, no. 1113 (1855); "Correspondenzblatt," 1860, p. 59.[*] ? *Hübnerella*, Hb., "Tin.," pl. xxxiv., p. 236, *c* (1801); Zell., "Isis," 1839, p. 215 (*partim* ♂); ? H.-Sch., "Sys. Bearb.," pl. cv., figs. 829, 830 (1854). ? *Dimidiatella*, H.-Sch., "Sys. Bearb.," v., p. 354 (1855). *Gratiosella*, Zell., "Linn. Ent.," iii., p. 312, *e* (1848). *Tityrella*, Sta., "Ins. Brit.," p. 304 (1854); "Nat. Hist. Tin.," i., pp. 148-159, pl. iii., fig. 3 (1855); "Man.," ii., p. 436 (1859); Frey, "Die Tineen," etc., p. 389 (1856); "Linn. Ent.," xi., pp. 429-430 (1857); Staud. and

---

[*] Herrich-Schäffer here writes: "*Basalella* ist älter als *tityrella*." Durrant notes: "Herrich-Schäffer's pl. cv., was issued in Heft 61 of the *Sys. Bearb.*, etc., in 1853, *vide*, *Correspondenzblatt des Zool. Ver. in Regensburg*, pp. 173-176 and 204-216 (1869)."

Wocke, "Cat.," 338, no. 3042 (1871); Hein. and Wocke, "Schmett. Deutsch.," p. 756 (1877); Sand. "Cat. Lep. Auv.," p. 201 (1879); Wallgrn., "Ent. Tidsk.," ii., p. 129 (1881); Snellen, "De Vlinders," etc., pp. 997-998 (1882); Sorhagen, "Die Kleinschmett. Brandbg.," p. 307 (1886); Hering, "Stett. Ent. Zeit.," lii., p. 221 (1891); Meyr., "Handbook," p. 721 (1895). *Fulgens*, Sta., "Ent. Mo. Mag.," xxv., pp. 12-13 (1888); Wood, "Ent. Mo. Mag.," xxx., p. 49 (1894); Meyr., "Handbook," etc., p. 721 (1895).

ORIGINAL DESCRIPTION.—*Basalella*, v. Heyd., Zell., p. 312, *c.* Sppl. 831.—Alis anterioribus orichalceo-fuscis, basin versus pallidioribus, fascia longe pone medium lata argentea, medio constricta, capite albo-luteo-pilosa, antennis subferrugineis. Grösser und mit längeren, schmaleren Flügeln als die bis jetzt beschriebenen Arten, nussbraun, fast ohne Metallglanz, die Wurzelhälfte licht bronzefarbig. Die breite Silberbinde hinter der Mitte, am Innenrande weiter von der Wurzel entfernt, in der Mitte eingeschnürt, die Franzen deutlich doppelt, ihre Wurzelhälfte mit groben braunen Schuppen, die Hinterflügel an der Wurzel ihres Vorderrandes mit einem Pinsel langer grober schwarzer Schuppen. Der Kopf überall weisshaarig, die Fühler und Beine bleich rostbraun. Ein Exemplar in F. R. Sammlung aus Kiel, darunter steckt ein Zettel: *Basalella*, v. Heyd. Ende August, Frankfurt-am-Main, auch von Zürich und aus dem Breisgau (Herrich-Schäffer, *Systematische Bearbeitung der Schmett. von Europa*, v., p. 354).

IMAGO.—Head pale ochreous. Anterior wings 5-6 mm.; shiny olive-fuscous; a pale golden rather oblique transverse fascia beyond the middle, its hinder edge concave; apex reddish-fuscous; cilia pale grey, with large brown scales at their base. Posterior wings and cilia pale grey. A tuft of dark scales at the base of the hind-wings.

VARIATION.—a. *fulgens*, Sta.—An especially brilliant form of *N. basalella* described as follows: Anterior wings shining olive-green to beyond the middle, then with a very brilliant silvery fascia, rather obliquely placed; sometimes the ground colour is a little darker immediately before the fascia; the apical portion of the wing is of a rich chocolate-brown, in certain lights looking blacker and contrasting strongly with the pale grey cilia; head whitish-ochreous, darker on the vertex. Exp. al. $2\frac{3}{4}$ lin. (Stainton, *Ent. Mo. Mag.*, xxv., p. 12).

COMPARISON OF N. BASALELLA WITH N. TURICELLA.—When Stainton redescribed *N. basalella* as *N. fulgens* he wrote: "The effulgent metallic brilliancy of the silvery fascia and the glossiness of the basal portion of the wing would alone serve to distinguish it from the usual beech-feeder *N. tityrella* (presumably *N. turicella*), a much duller and more sober-looking insect." Stainton's diagnosis of *N. tityrella* now referred to this species reads: "Alis anticis nitidis fuscis, vix olivaceo-tinctis, postice saturatioribus, fascia subobliqua pone medium dilute aurea, ad dorsum latiore; capillis luteis. Exp. al. $2\frac{1}{2}$ lin." (*Ins. Brit.*, p. 304).

EGG-LAYING.—This species is not at all particular as to the position in which the egg is laid, and places it on the upper and under surface of a beech-leaf indiscriminately.

MINE.—The larva makes a long contorted mine (usually on margin of leaf), at first very slender, with the excrement forming a black line; as the mine becomes broader, the excrement appears paler, yet, for some distance, fills the whole width of the mine, being placed in a series of little arcs of circles; after the first third of the mine, the excrement, which is now greenish-grey, does not occupy the whole width of the mine, but leaves a considerable space on either side; in the progress of the larva in its mine (generally towards the edge of leaf), it crosses several of the side ribs of the leaf. When full-fed, the larva leaves the mine to spin its cocoon (Stainton). Wood notes that "in the first part of the mine there is the usual concretionary arrangement of frass (embracing first two larval skins), the second portion is characterised by unmistakeable coiling; in the third part the coiling is gone, and the frass is scattered irregularly. (The coiling in the second portion is the best means of distinguishing the mine of this species from that of *N. turicella*, which never has the slightest indication of it.)" Sorhagen notes the mine as very fine at the commencement, much broader later; the frass-line at first brownish and filling the gallery, later greenish-grey, placed along the centre of the mine, which now has pale margins.

Larva.—The head is pale brown, the cephalic ganglia and ventral cord invisible (Wood). Length 2½ lines; pale greenish-white in colour; dorsal vessel greenish-brown; head pale brownish; mouth and margins of head reddish-brown (Stainton).

Cocoon.—The cocoons average 2 mm. in length and 1·3 mm. in width. It is of a much yellower colour than that of *N. turicella*; oval in outline and not very much flattened. The silk is arranged transversely, loosely, and has a somewhat coarse appearance. The cocoon proper is enveloped in a mass of loose flossy silk of the same colour as the cocoon, this outer covering, however, is much less thick than that covering the cocoon of *N. turicella*. Compared with the latter the cocoon of *N. basalella* is rather less in size, more orange in tint, made of coarser silk, and with a much thinner outer covering. [Described June 7th, 1898, from cocoons sent by Dr. Wood.] The cocoon is oblong-oval in shape, pale yellow in colour, and rather flossy. The pupa protrudes its anterior segments from the cocoon before the emergence of the imago (Stainton). Frey says that "the cocoon is oval, very little flattened, pale ochreous-yellow in colour, and rough."

Food-plant.—*Fagus sylvatica.*

Time of appearance.—This species is double-brooded, appearing in May and August, the larvæ of these broods feeding in October and June-July respectively. Imagines were taken at Arnhem, by De Rooy, on May 20th, 1873. Threlfall found larvæ on October 13th, 1887, at Ashton Park, which produced imagines the following April 10th, onwards. Stainton found larvæ at Box Hill, June 25th, 1861; he bred imagines from Lewisham larvæ April 14th-29th, 1853, and March 31st, April 1st, 8th, 12th, 14th, 28th, 1855. A specimen in the Stainton collection was bred by Threlfall, at Preston, May 3rd, 1888.

Localities.—Doubtful.—Devon: Dawlish (Stainton). Durham: Darlington (Stainton). Edinburgh: Balerno (Logan). Gloucester: Bristol (Stainton). Hereford: Tarrington (Wood). Kent: Lewisham (Stainton). Lancashire: Grange, Ashton Park, nr. Preston (Threlfall), Manchester (Stainton). Norfolk: King's Lynn, common (Atmore). Northumberland: Newcastle (Stainton). Perth: Moncreiffe Hill (Moncreiffe). Surrey: Box Hill (Douglas), Mickleham (Stainton), Haslemere (Barrett). Sussex: common—Abbott's Wood, Brighton, Worthing (Fletcher). Westmorland: Windermere, Witherslack (Hodgkinson).

Distribution.— Austria: Vienna (Metzner, *teste* Heinemann). France: Crevant (Sand). Germany: generally distributed (Heinemann and Wocke), Kiel (Boie), Frankfort-on-the-Main (Heyden), Freiburg (Reutti), Frankfort-on-Oder, Finkenkrug, Hamburg, Stettin (Sorhagen), Misdroy, Alt Damm, Hohenleese (Hering). Netherlands: Arnhem, Gravenhage (Snellen). Scandinavia: Scania (Wallengren). Switzerland: Bremgarten (Boll), Zürich (Frey).

NEPTICULA CASTANELLA, Stainton.

SYNONYMY.—Species: *Castanella*, Stainton, "Ent. Wk. Intell.," v., p. 123 (1859); "Ent. Ann.," 1860, p. 135; Staud. and Wocke, "Cat.," p. 339 (1871); Meyr., "Handbook," etc., p. 722 (1895).

ORIGINAL DESCRIPTION.—Mr. Edleston lately sent for determination two specimens of a *Nepticula*, taken among Spanish chestnut, for which he proposed the name *castanella*. This appears to be a distinct species, something allied to *N. tityrella*, but the fascia straighter and placed nearer the hind margin" (Stainton, *Ent. Weekly Intelligencer*, v., p. 123).

LARVA.—Yellow (Threlfall).

FOOD-PLANT.—*Fagus castanea* (Stainton) = *Castanea vesca* (Wocke).

TIME OF APPEARANCE.—Threlfall obtained larvæ October 2nd, 1880, on Spanish chestnut, at Dunham Park, but failed to rear imagines.

LOCALITIES.—CHESHIRE: Bowdon (Edleston). LANCASHIRE: Dunham Park, nr. Manchester (Threlfall).

DISTRIBUTION.—Staudinger and Wocke give: "Italy, Southern France, Tyrol (southern valleys)."*

NEPTICULA MALELLA, Stainton.

SYNONYMY.—Species: *Malella*, Sta., "Ins. Brit.," p. 304 (1854); "Nat. Hist. Tin.," i., p. 208, pl. v., fig. 3 (1855); "Man.," ii., p. 436 (1859); ? H.-Sch., "Sys. Bearb.," fig. 831 (1853), v., p. 351 (1855); Frey, "Die Tineen," etc., p. 388 (1856); "Linn. Ent.," xi., p. 427 (1857); Nolck., "Lep. Fn. Estl.," p. 781 (1871); Staud. and Wocke, "Cat.," p. 338 (1871); Hein. and Wocke, "Schmett. Deutsch.," p. 756 (1877); Sand, "Cat. Lep. Auvergne," p. 201 (1879); Bang-Haas, "N. H. Tids.," xiii., p. 217 (1881); Peyer., "Cat. Lep. Alsace," 2nd Ed., ii., p. 164 (1882); Snellen, "De Vlinders," p. 998 (1882); Sorhagen, "Die Kleinschmett. Brandbg.," p 357 (1886); Hering, "Stett. Ent. Zeit.," lii., p. 221 (1891); Meyr., "Handbook," etc., p. 722 (1895).

ORIGINAL DESCRIPTION.—*Nepticula malella*, n. sp. Alis anticis saturate fuscis, fascia subobliqua pone medium alba, parum nitida; capillis ferrugineis. Exp. al. 2 lin. Head and face reddish-yellow, slightly mixed with fuscous. Antennæ fuscous, basal joint whitish. Anterior wings dark fuscous, with a slightly oblique, almost white, slightly shining fascia beyond the middle; cilia fuscous. Posterior wings pale grey, with pale grey cilia. Appears in May and August, but not hitherto met with in the perfect state. The yellow larva mines in autumn and July in the leaves of the wild apple, making long galleries; the cocoon is bright yellow (Stainton, *Insecta Britannica*, p. 304).

IMAGO.—Head reddish. Anterior wings 4-5 mm.; dark fuscous; a slightly oblique, almost white, slightly shining fascia beyond the middle of the wing; cilia fuscous, pale externally. Posterior wings and cilia pale grey.

COMPARISON OF N. MALELLA WITH ITS ALLIES.—This belongs to that section of the genus in which the dark-coloured anterior wings have a single bright pale fascia; in this section it is distinguished by the anterior wings being dark fuscous, not with a purple or violet tinge, as in *N. plagicolella*, *N. acetosae* and *N. prunetorum*, nor with an olive tinge, as in *N. tityrella*; the fascia is placed rather more obliquely than in these allied species, and is hardly silvery; at any rate, it is less brilliant than in *N. plagicolella* and *N. prunetorum* (Stainton). Frey writes: "Es ist hiernach unsere Art etwas grösser, schmalflügliger, weniger glänzend, kaum violett angeflogen und mit viel helleren Franzen versehen als die übrigens nahe verwandte *N. plagicolella.* Auch der Kopf ist heller, gelblich behaart. Die Binde steht hinter der Mitte und ist etwas schief. Sie verläuft ganz gestreckt, ist schmal, mattsilbern erglänzend. Weitere Unterschiede von *N. betulicola*, *N. centifoliella*, etc., getraue ich mich jetzt nicht anzugeben. Dazu wäre ein viel grösseres Material erforderlich" (*Linn. Ent.*, xi., p. 428).

---

* We can trace none of these references to their source, and hence do not know who were the collectors who presumably collected this species in southern Europe

Egg-laying.—The egg is deposited on the underside of an apple-leaf, generally close to one of the ribs.

Mine.—The larva commences to mine in an irregular, rather tortuous gallery; at its origin this gallery is extremely slender, but it gradually becomes wider, and the excrement forms a distinct black line in the middle of it, leaving a pale space on each side of it. The larva leaves the mine to make its cocoon (Stainton). Frey writes: "Die Mine ist ein wenig stark gewundener Gang, welcher nach kurzem Verlaufe sich rasch beträchtlich breiter gestaltet und oft, bis 2‴ im Quermesser haltend, aufhört. Der Koth bildet eine schlanke, braunrothe Linie, so dass die Randtheile der Mine in sehr beträchtlicher Breite grünlich weiss und leer erscheinen. Die Mine fällt hierdurch sehr leicht in das Auge." Nolcken describes the mine as forming at first "a very slender, slightly twisting gallery, with fine interrupted frass-line, extending near to the pale edges; then it suddenly becomes much broader, more winding, the frass-line less regular, but broken into irregular heaps, or scattered indiscriminately over the path."

Larva.—Length 2 lines; very pale amber, the dorsal vessel reddish-brown, always conspicuous, even in the leaf; head small, pale brown, with a darker line on each margin; the hinder portion shows through the upper surface of the prothorax as two brown lobes separated by a pale line (Stainton).

Cocoon.—The cocoon is oval, yellow in colour, slightly flossy. The pupa protrudes its anterior segments before the emergence of the imago (Stainton). Frey writes: "Der Cocon ist oval, bräunlich gelb mit etwas rauher Oberfläche."

Time of appearance.—The insect is double-brooded, appearing in May and August, from larvæ to be found in September-October and June-July respectively. Fologne found full-fed larvæ by June 7th, 1860, nr. Brussels. Sang found mines on October 11th, 1857, at Richmond, August 5th, 1861, October 3rd, 1863, October 12th, 1870, July 15th, 1871, August 25th, 1873, at Darlington (*teste* Gardner). Nolcken found larvæ (of various sizes) abundantly at Pichtendahl, from July 2nd-27th, and the imago June 15th, 1862. Stainton caught imagines at Lewisham on May 21st, 1849, May 22nd, 1850, May 22nd, 1851, and bred them from the same locality on March 30th, 1854, July 18th, 1854, April 14th, May 6th, 1855, and July 25th-30th, 1856. Threlfall bred imagines in April, 1887, from larvæ obtained October 7th, 1886, at Grange.

Food-plants.—*Pyrus malus*, wild and cultivated varieties. Sorhagen adds: *Prunus spinosa*.

Localities.—Cambridge: Cambridge (Farren). Cheshire: Bowdon (Edleston). Derby: Burton (Sang). Dorset; ? Weymouth (Richardson). Dublin: Dublin (Stainton). Durham: Darlington (Sang). Essex: Walthamstow (Elisha). Gloucester: Bristol (Stainton); Hereford: Tarrington (Wood). Kent: Lewisham (Stainton). Lancashire: Manchester (Stainton), Grange district (Threlfall). Norfolk: Norwich (Barrett), King's Lynn (Atmore). Somerset: nr. Bristol (Mason). Westmorland: Witherslack (Hodgkinson). Yorks: Scarborough (Stainton), Doncaster, common (Corbett), York, very plentiful (Hind).

Distribution.—Denmark (Bang-Haas). France: Nohant, Indre (Sand). Germany: Friedland, Havelland, Hamburg (Sorhagen), Frankfort-on-the-Main (Schmid), Alsace (Peyerimhoff), Alt Damm (Hering). Netherlands: S. Holland, Friesland, not rare, Arnhem, N. Brabant (Snellen). Russia: Pichtendahl (Nolcken), Aland (Reuter). Switzerland: near Zürich (Frey).

NEPTICULA ATRICOLLIS, Stainton.

Synonymy.—Species: *Atricollis*, Sta., "Ent. Ann.," 1857, p. 112; "Man.," ii., p. 435 (1859); "Nat. Hist. Tin.," vii., p. 228, pl. ix., fig. 1 (1862); Hein., "Wien. Ent. Monats.," 1862, p. 313; Hein. and Sta., "Zool.," xxi., p. 8579 (1863); Nolck., "Lep Faun. Est.," p. 782 (1871); Staud. and Wocke, "Cat.," p. 338 (1871); Hein. and Wocke, "Schmett. Deutsch.," p. 758 (1877); B.-Haas, "N. H. Tidsk.," xiii., p. 218 (1881); Peyer., "Cat. Lep. Als.," 2nd Ed., ii., p. 164 (1882); Sorh., "Die Kleinschmett. Brandbg.," p. 346 (1886); Meyr., "Handbook," etc., p. 722 (1895).

Original description.—Alis anticis atris, fascia obliqua pone medium, in medio contracta, dorsum versus latiore, lutescenti-argentea. Exp. al. $2\frac{1}{4}$-$2\frac{1}{2}$ lin. Head and face reddish-yellow; palpi whitish; antennæ fuscous, basal joint white. Anterior wings deep black; a little beyond the middle is a yellowish-silvery fascia, rather obliquely placed, often attenuated in the middle, and the inner edge of the lower half expanding more or less towards the base; cilia of the hind margin whitish. Posterior wings grey, with grey cilia (Stainton, *Entom. Annual*, 1857, p. 112).

Imago.—Head ferruginous. Anterior wings 5-6 mm. in expanse; black in colour: a silvery slightly oblique transverse fascia, slightly attenuated in the centre, broadest on the inner margin, its inner edge slightly concave and outer edge straight, placed just beyond the middle of the wing; cilia blackish, with the tips distinctly whitish. Posterior wings and cilia grey.

Comparison of N. atricollis with N. angulifasciella, N. arcuatella, N. rubivora, etc.—From *N. angulifasciella* and *N. rubivora*, *N. atricollis* may be distinguished by the rusty yellow frontal tuft; from *N. arcuatella* the purer white tips of the cilia, and the distinct cilial line, as also the darker hind tarsi, serve to distinguish it (Heinemann). *N. atricollis* belongs to that section of the genus in which the black anterior wings have a bright silvery fascia. The only known species with which it can be confounded are *N. angulifasciella* and *N. arcuata*. From the former it may be distinguished by its smaller size, by the narrower anterior wings, and by the silvery fascia being less curved. From *N. arcuata* it is by no means easily distinguished. Both are of the same size, and the colour of the fascia seems precisely similar in the two species, but in the form of the fascia I think I can see this distinction, that in *N. atricollis* the curve or angulation of its inner edge takes place near the middle of the wing, but in *N. arcuata* it does not occur till the fold is reached (Stainton).

Egg-laying.—The egg is deposited on the undersurface of a leaf of hawthorn, wild apple, or pear.

Mine.—The first part of the mine is extremely fine, runs along the edge of a leaf, following the serrations, and is almost filled up with brown excrement. The mine then becomes wider, and finally expands into quite a large blotch, in which the excrement occupies only a small area, the blotch assuming a peculiar brownish-green tinge in hawthorn-leaves. Mines found by Wood in leaves of pear were rather different from those found on apple and hawthorn, those found on pear being typical of the "*angulifasciella* group," commencing in the body of the leaf with a bunch of convolutions, followed by a short gallery, and ending in a blotch. Wood notes that on apple and hawthorn the mine is much like that of *N. regiella*, commencing with a long gallery round the margin of the leaf, from which, as from a base, the blotch springs. Occasionally, however, the mines on apple and hawthorn do conform to type, when the egg happens to be deposited well away from the edge. The position of the egg, therefore, seems to determine the character of the mine; when it is laid upon or near the edge the larva appears to remain there, the bunch of convolutions being unravelled, as it were, and spread out along the margin.

Larva.—Length 2 lines. Pale greenish, with a dark green dorsal vessel; the 11th and 12th segments with a reddish tinge; the head and prothorax blackish-brown. There is a medio-ventral row of dark spots (Stainton). The larvæ of the autumn brood are supposed, by Warren, to hybernate through the winter, and to spin their cocoons on objects near their hybernacula in spring. Heinemann says that "the larva is yellow, with the head and spot on prothorax blackish." Nolcken queries the larva being "yellow," and describes it as "very pale dirty greenish in colour, usually with dark head, which is posteriorly black-brown. The intestinal canal is dark green, whilst along the venter a series of almond-shaped (or lozenge) spots are visible." Wood notes that the larva mines with the venter uppermost.

Comparison of the larva and mine of N. atricollis with those of its allies.—Of the larvæ living on *Crataegus oxyacantha*, probably only that of *N. ignobilella* can be confounded with that of *N. atricollis*, but this has a much paler head, and its mine has, at the commencement, pale margins on either side of the slender frass-line, whilst the frass completely fills up this part of the mine. The mine of *N. paradoxa*, Frey, from its forming a large brown spot, appears easy to separate from those of these species (Nolcken).

Cocoon.—The cocoons average about 2·1 mm. in length and 1·25 mm. in width. Each is roughly oval in outline and shape, black in colour, and covered over with a very dense coating of loose flossy black-brown silk. There is no rim, the cocoon being very like that of *N. rubivora*, but much more woolly, and reminds one something of an "eggar" cocoon in general form. The cocoons are spun up in moss, some with grains of sand adherent to the outer coats. [Described July 7th, 1898, under a two-thirds lens, from cocoons sent by

Mr. W. H. B. Fletcher.] Sorhagen describes the cocoon as "light blackish-green."

Food-plants.—Wild apple, hawthorn and pear, very rarely on the latter.

Time of appearance.—The species is double-brooded, the imagines appearing in May-June and August, from larvæ that have fed up the previous October and July respectively. Stainton captured an imago on June 17th, 1857, at Lewisham, and Threlfall has bred the imagines throughout May and June, from larvæ obtained at Grange the preceding August and September. Sang obtained mines on October 5th, 1861, September 26th, 1863, September 29th, 1871, October 2nd, 1874, September 30th and October 3rd 1878, at Darlington (*teste* Gardner). Nolcken found larvæ on September 6th, 1866, at Umbaid.

Localities.—Cambridge : Cambridge (Warren). Cheshire : Bowdon (Edleston). Durham : Darlington (Sang). Kent : Lewisham (Stainton). Hereford : Tarrington (Wood). Lancashire : Manchester (Boyd), Grange (Threlfall). Norfolk : Norwich (Barrett). Sussex : Arundel Park, abundant (Fletcher). Westmorland : Witherslack (Threlfall). Yorkshire : Doncaster (Warren), York (Hind).

Distribution.—Denmark : Between Brede and Lyngby (Bang-Haas). Germany : Brunswick and Silesia (Heinemann and Wocke), Alsace (Peyerimhoff), Wolfenbüttel (Heinemann), Stettin, Hanover (Sorhagen). Russia : Umbaid (Nolcken).

NEPTICULA ARCUATELLA, Herrich-Schäffer.

Synonymy.—Species: *Arcuatella*, H.-Sch., "Sys. Bearb.," v., p. 354 (1855); Hein., "Wien. Ent. Monats.," vi., p. 315 (1862); Hein. and Sta., "Zool.," xxi., p. 8381 (1863); Staud. and Wocke, "Cat.," p. 338 (1871); Hein. and Wocke. "Schmett. Deutsch., p. 759 (1877); Peyer., "Cat. Lep. Als.," ii., 2nd Ed., p. 165 (1882); Sorhgn., "Kleinschmett. Brandbg.," p. 346 (1886); Hering, "Stett. Ent. Zeit.," lii., p. 221 (1891); Meyr., "Handbook," etc., p. 723 (1895). *Arcuata*, Frey, "Die Tineen," etc., pp. 384-385 (1856); "Linn. Ent.," xi., p. 415 (1857); Sta., "Ent. Ann.," 1858, p. 97; "Man.," ii., p. 434 (1859); "Nat. Hist. Tin.," vii., p. 196, pl. ix., fig. 3 (1862); Nolck., "Lep. Fn. Est.," p. 784 (1871). *Arcuosella*, Dbldy., "List.," p. 36 (1866); Threlfall, "Ent. Mo. Mag.," xix., p. 113 (1882); Porritt, "List Yorks. Lep.," p. 172 (1886).

Original description.—1114. *Arcuatella* (*—ata*), Frey.—Fusca, capillis luteis, fascia alarum anter. media argentea, ante marginem interiorem rectangulariter fracta. Der Kopf viel stärker und dunkler gelb behaart als bei *N. basalella*, die Vorderflügel breiter, überall grob schuppig, die dicht gestellten Schuppen schwärzlich violett, die silberne Binde in der Mitte, von Vorderrande aus sehr schräg, erst kurz vor dem Innenrande fast rechtwinkelig gebrochen; das lichte Ende der Franzen kürzer, die Hinterflügel deutlich breiter. Von H. Frey aus unbeachteten Minen erzogen (Herrich-Schäffer, *Syst. Bear. der Schmett. von Europa*, vol. v., p. 354).

Imago.—Head reddish or ferruginous. Anterior wings 5 mm.; black; a slender, central, silvery-white transverse fascia, contracted and curved a little inwards medially; cilia whitish-grey. Posterior wings and cilia pale grey.

Comparison of N. arcuatella with N. angulifasciella and N. atricollis.—*N. angulifasciella* is a larger and blacker insect than *N. arcuatella*, with a more brilliant fascia; the latter can, however, be distinguished from the former, not only by its smaller size, but by the fascia being more slender, and by its outer edge being nearly straight (the outer edge of the fascia in *N. angulifasciella* being distinctly angulated). The imago of *N. arcuatella* is very difficult to distinguish from that of *N. atricollis*. They are of about the same size, but the latter is blacker, and the fascia is broader and more brilliant. *N. arcuatella*, too, has the anterior wings a little broader, and the curve in the fascia which, in this species, takes place on the fold, seems in *N. atricollis* to occur at about the middle of the wing, *i.e.*, nearer the costa (Stainton). *N. arcuatella* may be recognised by the tips of the cilia of the anterior wings being greyer, not so white, and by the paler legs. The fascia has the same direction as in *N. angulifasciella*; but is very narrow and less conspicuous (Heinemann).

Sexual dimorphism.—The frontal tuft of the male is generally pale luteous or ochreous, in the female more or less of a brownish-fuscous, especially at the hinder part, yet some males occur with brownish and females with yellowish frontal tuft (Heinemann).

Egg-laying.—The egg is laid on the upper surface of a leaf of *Potentilla fragariastrum* or *Fragaria vesca* (Stainton). Nolcken calls attention to this record, and states that he examined 4 mines, in all of which the egg was laid on the underside of the leaf.

Mine.—The first part of the mine consists of a much contorted gallery, in which the dark brown excrement is conspicuous; the gallery then becomes wider and less contorted, and at last widens out into a small blotch, in which there is very little excrement. The blotch is not formed until quite the end of the larval period. Heinemann describes the mine as "long, tortuous, with a slender frass-line." Frey notes the mine, in strawberry, as "long irregular, very much twisted, commencing as a very narrow gallery, running in and out along the margin of a leaf, with a very fine dark brown frass-line; later the mine widens gradually, and the frass becomes blackish, but still forms a very fine stripe with distinct margins." This description reminds one of that of *N. fragariella*. Nolcken calls attention to the discrepancies between various authors, in their descriptions of the mine, mode of egg-laying, etc. He describes the mine in *Tormentilla* (? *erecta*) as being without the pale margins, and the closely twisted spot (as described by Stainton). It begins moderately twisted, with perceptible width, which increases very gradually. After some time it expands into an irregular spot, which, owing to the small size of the leaf, often includes the earlier part of the mine. The frass, which completely fills the mine from its commencement to the blotch, shows three different forms of arrangement that may appear in either stage of the mine, *e.g.*, the frass may be granular and united into little heaps of varying size, or the granular pellets may be placed close together and form a regular row, or the pellets may be irregularly scattered, whilst, sometimes, band-like tracts of excrement are formed as if the deposit had been liquid. In the latter part of the mine the frass sometimes marks the path of the larva, at other times it is scattered irregularly. Seen from above, the frass appears black, held against the light it is somewhat transparent and greenish, composed of patches of unequal density, the darker patches leading insensibly into the form in which the excrement forms an opaque black band, often irregular, but conspicuous. Nolcken compared his with mines received from Heinemann, and found them very similar, although the latter had not always the tortuous beginning, were without light margins as far as the blotch, and had the excrement more granular and not deposited in a liquid form (a difference which Nolcken considers may have been engendered by a difference in the meteorological conditions at the time the mines were formed). He concludes that his mines and those of Heinemann belonged to the same species.

Larva.—Length 2 lines. Pale whitish-amber in colour, with a green dorsal vessel; head very pale brown, with the mouth and two lines receding from it darker (Stainton). Frey describes it as "yellowish-green, with a pale brownish head, and 2½ ‴ in length." Nolcken says "that it is pale yellow, with a green intestinal canal, and a very pale brown head." Wood notes that it mines with the venter uppermost.

Cocoon.—The larva leaves the leaf to spin its cocoon, the latter being oval, and blackish in colour (Stainton). Nolcken calls it "blackish-brown."

Food-plants.—*Fragaria vesca* and *Potentilla fragariastrum* (Frey), *Tormentilla* (*? erecta*) (Nolcken).

Time of appearance.—The species is double-brooded, according to Frey, appearing in May and again in July, from larvæ that feed up in August-September and in June respectively. Sang found mines on October 3rd-11th, 1863, September 2nd, 1865, and August 10th, 1873, at Darlington. Threlfall notes plenty of larvæ in wild strawberry on July 21st, 1876, at Grange, and he also bred imagines in May, 1887, from larvæ obtained at Grange, September 30th, 1886. Frey says there is a sparse summer brood of larvæ, and a more abundant one in September and October. Nolcken found larvæ from September 2nd-October 3rd, at Pichtendahl, where *Tormentilla* grows plentifully under shady bushes, in colonies varying much in age. He noticed also some mines empty at the commencement of September, which he considers may have been those of a summer brood.

Localities.—Durham: Darlington (Sang). Hereford: Tarrington (Wood). Kent: West Wickham (Stainton). Lancashire: Manchester (Boyd), Grange (Threlfall). Sussex: Clapham Woods, Worthing (Fletcher). Westmorland: Witherslack (Threlfall). Yorks: Scarborough (Wilkinson), Richmond (Sang).

Distribution.—Germany: Brunswick, Wolfenbüttel (Heinemann), Silesia (Heinemann and Wocke), Ratisbon (Stainton), Frankfort-on-the-Main (Heyden), Freiburg (Reutti), Alsace, Soultzmatt, Equisheim (Peyerimhoff), Friedland (Hering). Russia: Pichtendahl (Nolcken). Switzerland: Zürich (Frey).

NEPTICULA ANGULIFASCIELLA, Stainton.

Synonymy.—Species: *Angulifasciella*, Sta., "Cat.," p. 29 (1849); "Ins. Brit.," p. 304 (1854); "Nat. Hist. Tin.," i., p. 88, pl. i., fig. 3 (1855); "Man.," ii., p. 435 (1859); H.-Sch., "Sys. Bearb.," v., p. 350 (1855); Frey, "Linn. Ent.," xi., p. 417 (1857); Hein., "Wien. Ent. Monats.," vi., p. 314 (1862); Hein. and Sta., "Zool.," xxi., pp. 8380-8381 (1863); Staud. and Wocke, "Cat.," p. 338 (1871); Hein. and Wocke, "Schmett. Deutsch.," p. 758 (1877); Sand, "Cat. Lep. Auv.," pp. 201-202 (1879); Bang-Haas, "N. H. Tidsk.," xiii., p. 218 (1881); Peyer., "Cat. Lep. Als.," 2nd Ed., ii., p. 165 (1882); Sorhagen, "Die Kleinschmett. Brandbg.," p. 308 (1886); Walsm., "Ent. Mo. Mag.," xxvii., p. 152 (1891); Hering, "Stett. Ent. Zeit.," lii., p. 405 (1891); Meyrick, "Handbook," etc., p. 722 (1895).

Original description.—*Nepticula angulifasciella*, n. sp. ? *Argyropeza*, Z. var. a, 320. Smaller than *argentipedella*. Anterior wings black, with two nearly opposite trigonal silvery spots a little beyond the middle of the wing, sometimes united and forming an angulated fascia; head ferruginous (Stainton, *Sys. Cat. of the Brit. Tin. and*

Pterophoridae, p. 29). This description is extended by Stainton (*Insecta Britannica*, p. 304) as follows: "Alis anticis nigris, maculis duabus oppositis in medio argenteo-albis, in fasciam angulatam confluentibus; capillis luteis. Exp. al. 2½ lin. Head and face deep luteous. Palpi whitish. Antennæ dark fuscous, basal joint whitish. Anterior wings black, with a silvery-white spot on the costa about the middle, and a similar silvery-white spot on the middle of the inner margin; these spots frequently unite to form a slender angulated fascia; cilia whitish. Posterior wings grey, with paler cilia."

Imago.—Head yellowish. Anterior wings 5-6 mm.; black in colour; two opposite silvery-white spots in the centre, which frequently unite to form a transverse fascia; faint blue-grey tinge towards apex; cilia with two dark divisional lines beyond these white. Posterior wings grey, cilia pale grey.

Comparison of N. angulifasciella with its allies.—In *N. angulifasciella* the cilia have two dark divisional lines that are placed more obliquely than in *N. agrimoniella* and *N. atricollis*, moreover, the frontal tuft is yellower than in those species. *N. angulifasciella* is distinguished from *N. rubivora* by the yellow frontal tuft, and from *N. arcuatella* by the whiter tips of the cilia of the anterior wings and the darker cilial line (Heinemann). *N. angulifasciella* belongs to that section of the genus in which a single brilliantly metallic fascia adorns the anterior wings—this fascia, being silvery-white, at once distinguishes the species from *N. aurella*; to *N. argentipedella* and *N. malella* it is more closely allied, but in these the fascia is straight, whereas in *N. angulifasciella* it is angulated, and sometimes divided into opposite spots; the darker ground colour of the anterior wings also distinguishes it from *N. malella* and the larger *N. argentipedella* (Stainton).

Egg-laying.—The egg is deposited on the under surface (rarely on the upper surface) of a rose leaf, near the midrib.

Mine.—The mine is a compound of the gallery and blotch form, starting first as a gallery, which comprises the greater part of the structure. It commences as an extremely contorted gallery, the numerous turns of which are so close together that they almost form a blotch; the second part of the mine is broader, less tortuous, and in this the excrement is placed rather irregularly; the increasing width of the mine makes it assume, in its final portion, the form of a blotch. The formation of this blotch portion does not commence with the third larval moult, but is delayed until almost the end of the larval period. As soon as the larva commences to burrow, it stains the leaf, and the little purple spots in the rose-leaves show at once where the larva has begun to mine. The larvæ are sometimes very gregarious, a single wild-rose bush sometimes having almost every leaf occupied with larvæ. Heinemann says: "The mine is very tortuous, with a slender excremental line, but generally ends in a large blotch."

Larva.—The full-grown larva is about 2 lines in length. It is of a pale greenish-white colour, with the exception of the three terminal segments, which are pale amber; the dorsal vessel is green; the head and prothorax brown (Stainton). The larva is greenish-white, with green dorsal line and brownish head. It occurs in the leaves of wild roses growing in shady borders of woods (Heinemann). Larva whitish, with dark green dorsal vessel (Walsingham).

Cocoon.—Hind says that it is "nearly black." Stainton gives its colour as dark green, oval in shape. The larva remains in the cocoon for some time before assuming the pupal state. Frey writes: "Der Cocon ist dunkel grünlich-braun, ziemlich rundlich und mässig flach." Sorhagen describes the cocoon as "dark green."

Food-plants.—*Rosa canina* and *Poterium sanguisorba*. Abundant at Doncaster in *R. canina*, but not in *R. arvensis* (Corbett). *Rosa sempervirens* (Walsingham).

Time of appearance.—Although this species appears to be single-brooded, the imagines are to be found from the end of May until July. These appear to come entirely from larvæ that feed up the previous September-November. Stainton writes: "By keeping the collected larvæ out of doors all the winter of 1854-1855, I succeeded in rearing a fine series of the perfect insects, which made their appearance from July 13th-28th, 1855, a sufficient proof that the insect is only single-brooded." In 1856, he had imagines emerge from July 17th-28th, whilst in 1851 he found imagines on June 22nd, 1851, on palings at Beckenham. Threlfall bred imagines from June 15th-30th, 1879, from green larvæ found at Windermere, October 17th, 1878. Peyerimhoff makes the species single-brooded at Alsace, the imagines appearing in June, from October larvæ. Sang found mines at Darlington on October 6th, 1878. Walsingham, however, found larvæ at Cannes and Valescure from February 27th to March 7th, 1890, and bred the imagines from these on June 13th of the same year. Perhaps, so far south, a second brood occurs. Jordan records that in October, 1865, there were no Nepticulid larvæ in the rose-bushes in a garden at Teignmouth. On November 10th he returned for one day only, and the same rose-bushes were now literally swarming with the larvæ of *N. angulifasciella*. Some of the mines were already empty, and in others there were full-fed larvæ, often several in one leaf.

Localities.—Cambridge: Cambridge (Farren). Cheshire: Bowdon (Edleston). Derby: Burton-on-Trent (Sang). Devon: Teignmouth (Jordan). Dorset: Portland, Weymouth (Richardson), Glanvilles Wootton (Dale). Durham: Darlington (Sang). Gloucester: Bristol (Stainton). Hereford: Tarrington (Wood). Kent: Lewisham and Beckenham (Stainton). Lancashire: nr. Manchester (Stainton), Preston and Grange (Threlfall). Norfolk: Myntlyn, Bawsey (Barrett), King's Lynn (Atmore). Renfrew: Bishopton, nr. Paisley (King). Suffolk: Hacheston (Harker). Sussex: Worthing, Arundel, Horsham, Sompting, abundant in *Rosa canina* (Fletcher), Guestling (Bloomfield). Westmorland: Windermere (Threlfall), Witherslack (Hodgkinson). Yorkshire: Scarborough (Wilkinson), Doncaster (Corbett), Richmond (Sang), York (Hind).

Distribution.—Belgium: nr. Brussels (Fologne). Denmark: generally distributed in north-east Zealand (Bang-Haas). France: Nohaut, Indre (Sand), Cannes, Valescure (Walsingham). Germany: widely distributed, Brunswick, etc. (Heinemann), Berlin (Bouché), Hamburg (Sorhagen), Frankfort-on-the-Main (Heyden), Alsace (Peyerimhoft). Breslau (Zeller), Alt Damm, Friedland (Hering). Switzerland: Bremi, nr. Zürich (Frey).

NEPTICULA RUBIVORA, Wocke.

Synonymy.—Species: *Rubivora*, Wocke, "Jahres-Bericht der Schles. Gesell. fur vaterl. Kultur," vol. xxxviii., p. 132 (1860); Hein., "Wien. Ent. Monats.," vi., p. 315 (1862); Hein. and Sta., "Zool.," xxi., p. 8381 (1863); Staud. and Wocke, "Cat.," p. 338 (1871); Nolck., "Lep. Fn. Estl.," p. 783 (1871); Frey, "Stett. Ent. Zeit.," 1871, p. 125; Hein. and Wocke, "Schmett. Deutsch.," p. 759 (1877); Sand, "Cat. Lep. Auv.," p. 202 (1879); Peyer., "Cat. Lep. Als.," 2nd Ed., ii., p. 165 (1882);

Sorhgn., "Die Kleinschmett. Brandbg.," p. 346 (1886); Walsm., "Ent. Mo. Mag.," xxvii., p. 152 (1891); Meyr., "Handbook.," etc., p. 722 (1895).

ORIGINAL DESCRIPTION.—*Nepticula rubivora*, n. sp. Alis ant. grossiuscule squamatis nigris, fascia media argentea nitidissima parum obliqua, capillis nigris, conchulis flavescentibus. Expans. alar. c. 4 millim. Hat einige Aehnlichkeit mit *N. angulifasciella* und *N. agrimoniella*, von denen sie sich aber leicht durch den tief schwarzen Kopf unterscheiden lässt. Von den übrigen auf *Rubus* lebenden Arten trennt sie sich durch die rein silberne Binde und die grobschuppigen, weder violett noch goldig tingirten Vorderflügel. Grösse etwas unter *N. angulifasciella*, mein grösstes ♀ misst von einer Flügelspitze zur anderen etwas über, das kleinste ♂ wenig unter 4 mm. Der Körper ist im Verhältniss zur Länge der Flügel sehr robust gebaut. Kopfhaare schwarz, Gesicht blassgelblich, Fühler hellgelblichgrau, nach der Spitze zu gebräunt, Muschel auf der Oberseite glänzend weisslich, unterseits hellgelb. Rücken schwarz, Beine braungrau mit hellgelben Tarsen. Die Vorderflügel sind ziemlich grobschuppig, tiefschwarz, gegen die Flügelspitze mit einigen eingestreuten weisslichen Schüppchen. Der Saum ist durch eine Bogenlinie schwarzer Schuppen begrenzt; Franzen weisslich. In der Mitte der Vorderflügel liegt die meist etwas nach aussen convexe Silberbinde, die ein wenig schief gerichtet ist, indem sie am Vorderrande etwas weiter nach innen endet als am Innenrande. Hinterflügel dunkelgrau mit gleichen Franzen. Unterseite der Vorderflügel schwärzlich mit hellgrauen Franzen. Hinterflügel wenig heller als auf der Oberseite. Die Raupe bewohnt die Blätter von *Rubus caesius* an feuchten schattigen Plätzen in der Nähe der Oderufer bei Breslau. Ihre Mine ist unregelmässig und so vielfach verschlungen, dass ihre Richtung oft gar nicht deutlich zu erkennen ist und sie einen grossen schmutziggelblichen Fleck darstellt, in dem einzelne Inselchen des unversehrten Blattgrüns stehen. Die Farbe der Raupe ist hellgraugrün; der Kopf blassbraun. Die Erscheinungszeit der Raupe, von der ich nur eine Generation beobachtete, ist eine sehr späte, von Ende September bis Ende October. Das Cocon ist dunkelbraun, von ovaler Form und wenig gewölbt. Den Falter habe ich noch nicht im Freien gefunden, im warmen Zimmer, in das ich die Puppen Anfang Februar brachte, kamen mir die Schmetterlinge erst gegen Ende April aus (Wocke, *Jahres-Bericht der Schlesischen Gesellschaft fur vaterländische Kultur*, xxxviii., pp. 132-133).

IMAGO.—Head black Anterior wings 5 mm., narrow, with large scales; black in colour; the somewhat oblique transverse silvery median fascia bent on the fold; the cilia blackish with white tips. Posterior wings and cilia dark grey.

COMPARISON OF N. RUBIVORA WITH ITS ALLIES.—*N. rubivora* has some similarity with *N. angulifasciella* and *N. agrimoniella*, from which, however, it is easily distinguished by the deep black head. From the rest of the species living on *Rubus*, it is separated by the clean silver band, and the coarsely-scaled forewings being neither tinged with violet nor golden (Wocke). All the specimens of *N. rubivora* very closely resemble *N. angulifasciella*, yet *N. rubivora* is easily distinguished by the black frontal tuft. It is also smaller, and the anterior wings appear rather narrower, and of a more uniform width, and their colour a deeper black. The antennæ are short; the eye-caps small and pure white (Heinemann).

Egg-laying.—The egg is laid on the underside of a leaf (Nolcken).

Mine.—The mine is irregular, and twisted so frequently that its direction is not always easy to follow. It forms, at last, a large, dirty, yellowish blotch, in which stand isolated islets of the uninjured green of the leaf. Nolcken notes that the mines are differently coloured in the leaves of *Rubus chamaemorus* and *R. sexatilis* (a difference not marked in the dried leaves). Its commencement is broader than that of the mines of most species, forms first some closely compressed windings, then stretches itself in curves for a short distance, and only gradually increases in width, until it suddenly enlarges into a large blotch, bounded by convex lines or the vein of a leaf. From the commencement to the blotch, the granular frass lies in small patches (with scattered pellets between), which stretch from side to side, so that there are pale patches, but no pale margins. In the blotch the frass at first shows the track of the larva, but is afterwards scattered irregularly. Sometimes the blotch takes in the whole of the earlier part of the mine, although even then its direction can be traced. The larva quits the leaf by the upper side. Heinemann notes that both the larva and mine are like those of *N. angulifasciella*.

Larva.—Wocke describes the larva as "light greyish-green, its head pale brown." Nolcken says that "the larva is very pale greenish, almost transparent, with light-green alimentary canal just as clear; the head pale yellowish-brown, with the sutures and mouth-parts darker; antennæ scarcely visible but faintly shaded with grey; the ventral surface with lozenge-shaped spots, which, however, are rounded off, and are united like a string of pearls."

Cocoon.—The cocoons examined (17 in number) average 2 mm. in length and 1·25 mm. in width. The cocoon is almost ovate in shape, much deeper than the ordinary Nepticulid cocoon, exceedingly irregular, and without any rim in those examined. The cocoons are spun up among moss and sand, many pieces of the latter being attached to the outside. The colour of the cocoons is black, generally smooth, but with a number of loose black-brown fibres scattered here and there, probably at the points of attachment where the coccon has been fastened to pieces of moss. [Described July 7th, under a two-thirds lens, from cocoons sent by Mr. W. H. B. Fletcher.] Wocke describes the cocoon as being "dark-brown in colour, of oval form and little vaulted." Nolcken says that "the freshly-made cocoons are blackish violet-grey, often with a paler greenish margin."

Food-plants.—*Rubus caesius*, preferring plants growing in damp, shady places (Wocke), *R. sexatilis* and *R. chamaemorus* (Nolcken), *R. caesius* and *R. chamaemorus* (Sorhagen), *R. fruticosus* (Walsingham).

Time of appearance.—The species is probably double-brooded in the south, single-brooded in the central and north, of Europe. Walsingham obtained larvæ from March 29th-April 3rd, 1888, at Cannes, which produced imagines June 1st-17th, 1888, whilst others, obtained in March, 1889, emerged from May 27th-June 12th, 1889. Peyerimhoff notes it as single-brooded in Alsace, the October larvæ producing imagines in June, whilst Sand also says that in Auvergne, October larvæ produce imagines in June. Wocke notes only one brood at Breslau, the larvæ appearing from the end of September until the end of October, and producing in a warm room (into which the cocoons were brought at the commencement of February) imagines towards the end of April. Nolcken says that he has no doubt there is a summer brood, but has never obtained it. On the other hand, the autumn larvæ, from which the spring imagines come, are exceedingly abundant, 30 mines sometimes occurring in a leaf. They always appear in little colonies, and seem to dislike very shady spots.

Localities.—Cambridge: very abundant in 1883 (Warren). Essex: very abundant in 1883 (Warren). Lincolnshire: Lincolnshire coast (Fletcher). Sussex: Arundel, Amberley, locally abundant (Fletcher).

Distribution.—Belgium: Brussels (Stainton). France: Nohaut, Indre (Sand), Cannes (Walsingham). Germany: generally distributed (Heinemann and Wocke), banks of Oder, at Breslau (Wocke), Brunswick, Wolfenbüttel (Heinemann), Stettin, Hanover. Leignitz (Sorhagen), Alsace, Colmar, Neuland, etc. (Peyerimhoff). Russia: Oesel (Sorhagen), Tursa Moor, very abundant (Nolcken), Russian Baltic Islands (Nolcken *teste* Frey). Switzerland: nr. Zürich (Frey).

NEPTICULA AGRIMONIÆ, Frey.

Synonymy.—Species: *Agrimoniae*, Frey, "Ent. W. Int.," iv., pp. 43-44 (1858); Heyd., "Stett. Ent. Zeit.," 1861, p. 41; Sta., "Ent. Ann.," 1868, p 47; Ibid., 1874, p. 46; Fletcher, "Ent. Mo. Mag.," xviii., p. 211 (1882). *Agrimoniella*, H.-Sch., "Corresp.," etc., 1860, p. 60; Sta., "Ent. W. Int.," viii., p. 176 (1860); Hein., "Wien. Monats.," 1862, p. 312; Sta., "Nat. Hist. Tin.," vii., p. 148 (1862); Sta. and Hein., "Zool.," 1863, pp. 8378-8379; Staud. and Wocke, "Cat.," p. 338 (1871); Hein. and Wocke, "Schmett. Deutsch.," p. 787 (1877); Sand, "Cat. Lep. Auv.," p. 201 (1879); Sorhagen, "Die Kleinschmett. Brandbg.," p. 346 (1886); Hering, "Stett. Ent. Zeit.," lii., p. 221 (1891); Meyr., "Handbook," etc., p. 722 (1895).

Original description.—The larvæ collected by Herr Hoffmann, at Ratisbon, on *Agrimonia eupatoria*, changed to pupæ inside the mines (see, *Ent. W. Intell.*, iii., p. 59), and from these I have now bred eight specimens of a new and totally distinct species, which comes next to *N. angulifasciella*, but is rather larger and more beautiful, the head of a darker red, and the fascia more shining. For this species I propose the name of *N. agrimoniae* (Frey, *Ent. Weekly Intelligencer*, vol. iv., pp. 43-44).

Imago.—Head of ♂ rusty yellowish, of ♀, dark brown. Anterior wings 5 mm.; coarsely scaled, black or blackish-grey in colour, with a central silvery or slightly golden transverse fascia, sometimes angulated centrally, at other times broken into two opposite equal-sized spots; the cilial line forms a curve round apex, and runs to anal angle, the cilia grey with black tips. Posterior wings and cilia pale grey.

Sexual dimorphism.—The male has the anterior wings more grey than black, and the female has a more decided golden lustre to the otherwise silvery transverse fascia. The frontal tuft in the male is generally rusty yellow, at the neck brownish, whilst in the female this is generally dark brown, yet males do occur with brown, and females with ferruginous, heads (Heinemann).

Comparison of N. agrimoniæ with its allies.—Frey notes *N. agrimoniae* as being larger, more beautiful, the head darker red, and the fascia more shining than in *N. angulifasciella*. Herrich-Schäffer notes that *N. agrimoniae* differs from *N. arcuatella* and *N. angulifasciella* by the silvery fascia being quite vertical and parallel to the margin. From *N. freyella* it is distinguished by its larger size, the head being less black, and the base of the anterior wings less glossy. Heinemann observes that the anterior wings of *N. agrimoniae* are of unusual breadth beyond the middle, and the cilia very long, so that the distance from the costa to the anal angle is greater than is usual in other species of this group. He also says that the male may be distinguished from the other allied species independently of the form of the wings, by the paler greyer colour of the anterior wings, and from *N. arcuata*, which is also grey, by the darker hind tarsi; the female may be generally recognised by the brown frontal tuft; besides, in the other species, the fascia runs rather obliquely from the costa to beyond the middle, is generally refracted below the middle, and is further from the base to the inner margin than on the costa. From *N. atricollis*, which sometimes has the fascia of almost the same form, the longer antennæ serve to distinguish it. Fletcher considers that *N. agrimoniae* appears to connect *N. argyropeza (apicella)* to the group to which *N. angulifasciella* belongs, the male resembling the former, the smaller darker female with its brighter fascia resembling the latter.

Mine.—The mine forms a long, tortuous, rather broad, brown gallery, which often expands into a blotch that sometimes fills an entire leaflet (Heyden). Heinemann notes it as long and tortuous, with a slender excremental track. Fletcher mentions that from 20-40 mines may often be found in a single leaf of *Agrimonia eupatoria*, preference being shown for the radical and lower cauline leaves of those plants well sheltered by brambles.

Larva.—The larva is greenish-yellow, with brownish head and brownish spots on prothorax. Heyden notes: "Raupe weniger niedergedrückt, glatt, glänzend, grünlichgelb. Kopf bräunlichgelb mit braunen Flecken und dunkelm Mund. Nackenschild mit zwei braunen Flecken."

Cocoon.—The cocoon is placed inside the mine, generally in one of the serrations of the leaf. Its colour appears to vary, as Frey calls it "blackish," Herrich-Schäffer "a beautiful violet," Heinemann "violet-coloured," whilst Heyden notes the cocoon as a "flat, oval, yellowish-white or brownish structure."

Food-plant.—*Agrimonia eupatoria*.

Time of appearance.—The species appears to be single-brooded. Larvæ and cocoons were first discovered by Hoffmann, at Ratisbon, in the middle of October, 1857. Some of these sent to Frey produced imagines in April, 1858. Larvæ were also very abundant from the middle of September until the end of October, 1858, in shady woods, near Frankfort-on-the-Main and Offenbach, and these produced imagines at the end of May (Heyden). It was added to the British list by Fletcher, who found larvæ in October-November, 1879, in Sussex, and bred imagines from these in the following spring. Herrich-Schäffer says that the imago appears in the spring, a week or two later than that of *N. aeneofasciella*.

Localities.—Sussex: Abbott's Wood (Fletcher).

Distribution.—France: Nohaut, Indre (Sand). Germany: Ratisbon (Hoffmann), Frankfort-on-the-Main and Offenbach (Heyden), Wolfenbüttel (Heinemann), Brunswick and Silesia (Heinemann and Wocke), Alt Damm (Hering).

Group V.—Cilia of the anterior wings with a distinct or indicated divisional line, beyond which they are pale. Anterior wings with a distinct non-metallic pale transverse fascia sometimes interrupted at or beyond the middle.

NEPTICULA MYRTILLELLA, Stainton.

Synonymy.—Species: *Myrtillella*, Sta., "Ent. Weekly Intell.," ii., p. 44 (1857); "Ent. Ann.," 1858, p. 95; "Man.," ii., p. 434 (1859); "Nat. Hist. Tin.," vii., p. 236, pl. xi., fig. 2 (1862); Hein., "Wien. Ent. Monats.," vi., p. 317 (1862); Hein. and Sta., "Zool.," xxi., p. 8383 (1863); Staud. and Wocke, "Cat.," p. 338 (1871); Nolck., "Lep. Fn. Estl.," p. 786 (1871); Frey, "Stett. Ent. Zeit.," 1871, p. 126; Hein. and Wocke, "Schmett. Deutsch.," p. 760 (1877); B.-Haas, "N. H. Tids.," xiii., p. 218 (1881); Wallgrn., "Ent. Tids.," ii., p. 129 (1881); Sorhagen, "Die Kleinschmett. Brandbg.," p. 308 (1886); Hering, "Stett. Ent. Zeit.," lii., p. 221 (1891); Meyr., "Handbook," etc., p. 723 (1895).

Original description.—*Nepticula myrtillella*. Professor Frey has succeeded in rearing the *Nepticula* from the *Vaccinium myrtillus*, and has placed it in his collection with the above name. The insect has some affinity with *N. salicis*, but the fascia is more distinct, and broader, and placed nearer towards the apex of the wing (Stainton, *Entom. Weekly Intelligencer*, ii., p. 44, May 9th, 1857). Later he diagnosed the species as follows: "Alis anticis saturate fuscis, fascia obliqua, tenui albida pone medium; capillis ferrugineis. Exp. al. 2½ lin. Head ferruginous. Antennæ dark fuscous. Abdomen and legs grey. Anterior wings dark fuscous, with an oblique, rather slender whitish fascia beyond the middle, cilia whitish. Posterior wings pale grey, with pale grey cilia" (*Ent. Annual*, 1858, p. 95).

Imago.—Head ferruginous. Anterior wings 4-5 mm.; dark fuscous, tinged with bluish; a rather slender, whitish, transverse fascia, nearly uniform in width beyond the middle; cilia dark grey, paler beyond the cilial line. Posterior wings and cilia pale grey.

Comparison of N. myrtillella and N. floslactella.—*N. myrtillella* is very closely allied to *N. salicis* and its allies, and can scarcely be distinguished by constant characters. On the whole it is smaller than *N. salicis* (I have specimens only one line and a half in expanse), the anterior wings have the same ground colour, and blue gloss, but are not so inclined to yellowish as is *N. salicis*, the individual scales not having their bases yellowish as in that species, but are more uniformly dark. The fascia is not composed of two opposite spots, but is narrow, of nearly uniform width, less oblique, purer white (less yellow) with a faint silky lustre. The dark scales at base of cilia lie more regularly than in *N. salicis* and *N. floslactella*, and form by their ends a regular more strongly curved divisional line, whereas in *N. salicis* the scales are more irregularly placed, are rather abruptly truncate posteriorly, and some project into the outer half of the cilia. Beyond this line, the cilia are of a purer paler grey, without the yellowish colouring round the apex of the wing, as in *N. salicis*; at the anal angle and at the inner margin they are grey. The frontal tuft is bright rusty yellow; in *N. salicis* it is more of a brownish-ochreous, otherwise, in both species, the eye-caps and cervical tuft are yellowish-white; the longer antennæ are blackish, the legs grey; the hinder tibiæ spotted with pale in the middle and at the end; the posterior tarsi are pale grey. Since, moreover, *N. salicis* and *N. myrtillella* both vary to some extent in the above-given distinctive characters, the certain recognition of specimens which have not been bred is extremely difficult; indeed, I must admit that, although I have bred great numbers of both species, yet I should have referred individual specimens of one species to the other, had I not been guided by the information furnished by the larvæ (Heinemann). Stainton says: "*N. myrtillella* is most nearly related so *N. salicis*, but the fascia is more slender and brighter than in that species." Heinemann refers *N. fagella*, H.-Sch. (= *N. fagi*, Frey) also to this species (*vide.*, *Zool.*, xxi., p. 8384), but Frey supposed his *N. fagi* might be a small summer brood of *N. carpinella* (*Lep. der Schweiz*, p. 425).

EGG-LAYING.—The egg is laid on the underside of a leaf of *Vaccinium*, either on, or very close to, the midrib (Stainton); sometimes on the margin of a leaf (Nolcken).

MINE.—The mine is at first much contorted, and of a reddish tinge, the excrement forming a rather broad, irregularly waved black line; when the larva is about half-grown, the mine becomes more blotched, the excrement only occupying a small area. Some mines are said to run along the edge of a leaf, going in and out the serrations (Stainton). Heinemann says "the mine is serpentine, unless the confined space compels a blotch-like formation." Nolcken notes the mine as being "sometimes placed near the margin, the larva extending its mine therefrom until it occupies the entire half of a leaf; in other cases the mine is commenced near the midrib, and spreads to the margin. The first part of the mine is narrow (scarcely wider than the body of the larva), then it increases from five to ten times its original width, the windings still, however, remaining close together; finally the larva eats away the partitions between the convolutions, and converts the gallery into a large irregular blotch. The frass is arranged in little heaps, forming a broken line, in the first part of the mine; in the second part the heaps are larger, but the frass always occupies comparatively little space, the greater part of the gallery being represented by the pale excavated portions of the mine."

LARVA.—Length 2 lines. Amber-yellow in colour; head pale brown, the mouth and two receding hinder lobes darker brown (Stainton). Nolcken describes it as "paler or darker yellow, with transparent, pale-brownish head, the mouth and sutures darker brown; the yellowish-grey (or brownish) dorsal vessel indistinctly seen on back; a series of brown lozenge-spots on venter, the hinder ones longer and more sharply pointed." Wood notes it as mining with the dorsum uppermost.

COCOON.—The cocoons (7) average 3 mm. in length, and 1·8 mm. in width, forming, roughly, a long oval in outline, and with but little difference in the size of the ends. The cocoons are spun on the upper side of a *Vaccinium* leaf, and have accommodated themselves to the surface, sometimes showing a rather broad flange where there has been a fold in the leaf. The upper portion is well arched, the apex being almost central, but the cocoons appear to be thin, and to collapse irregularly in some places. They are uniformly yellow-ochreous in colour, inclining to orange, the main structure moderately smooth, but with a considerable amount of adherent pale, flossy, silken fibres all over it, although these are more abundant round the rim than elsewhere. The empty pupa-case projects below the rim; it is absolutely transparent and colourless, without any trace of shading, and extremely delicate. [Described under a two-thirds lens, June 28th, 1898, from cocoons sent by Mr. W. H. B. Fletcher.] Heinemann notes it as "broad and flat, rather long, and brown." Nolcken says "it is generally brownish-yellow, but both the colour and shape are very variable."

FOOD-PLANTS.—*Vaccinium myrtillus* and *V. uliginosum*. [Hodgkinson makes (*E.M.M.*, xix., p. 44) the astounding statement that larvæ of this species were "mining leaves of *Polypodium* as well as those of *Vaccinium*."]

TIME OF APPEARANCE.—The species is said to be double-brooded, the imagines appearing in May-June and August-September from larvæ to be found in October-November and July-August respectively. Mines were first found by Schmid in October, 1856, near Frankfort-on-the-Main. Nolcken found larvæ from the commencement to the 20th of September, and the larvæ had all spun up by the commencement of October. He thinks these were probably the progeny of an earlier brood. Stainton found larvæ on the hillside above the Bridge of Allan, on August 12th, 1858, and in 1859 gave the species as double-brooded in the *Manual*. It was bred by Frey in April, 1857, but Evans took imagines at Newpark on June 7th, 1895, Hodgkinson on June 9th, 1870, at Witherslack, whilst Barrett met with imagines throughout June, 1886, at Cannock Chase. Cook met with larvæ in abundance on July 30th, 1857, at Scarborough, and Edleston in October, 1856. Heinemann says the larvæ feed in July and at the end of September, so that the indication is that the July-August larvæ produce imagines in August-September. Sorhagen also gives larvæ in July and again in September-October. Sang obtained mines on August 4th, 1873, at Scarborough, September 10th, and September 18th, 1873, at Richmond. Bower records larvæ as being common on September 23rd, 1891, in Teesdale. Threlfall bred imagines in May, 1887, from larvæ obtained September 7th, 1886, at Stalybridge.

LOCALITIES.—CHESHIRE: generally distributed on moors, Bowdon, etc. (Edleston), Stalybridge (Threlfall). DURHAM: Teesdale (Bower). HEREFORD: Tarrington (Wood). LANCASHIRE: widely distributed on moors, nr. Manchester, etc. (Edleston). MIDLOTHIAN: Newpark (Evans). PERTHSHIRE: Rannoch (Fletcher), Dunkeld (Stainton). STAFFORDSHIRE: Cannock Chase (Barrett). STIRLINGSHIRE: hill above Bridge of Allan (Stainton). WESTMORLAND: Windermere, Witherslack (Hodgkinson). YORKSHIRE: Scarborough (Wilkinson), Blubberhouses (Walsingham), Richmond (Sang), Sheffield (Doncaster), north Yorkshire in Teesdale district (Bankes).

DISTRIBUTION.—Denmark: north-east Zealand (Bang-Haas). Germany: widely distributed (Heinemann and Wocke), Frankfort-on-the-Main (Schmid), Brunswick (Heinemann), Glogau (Zeller), Havelland, nr. Berlin, Hamburg, Hanover (Sorhagen), Alt Damm, Warnow, nr. Misdroy, Liebeseele (Hering). Russia: Pichtendahl, etc. (Nolcken). Scandinavia: Scania (Wallengren). Switzerland: nr. Zürich (Frey).

NEPTICULA SALICIS, Stainton.

SYNONYMY.*—Species: *Salicis*, Sta., "Ins. Brit.," p. 302 (1849); "Nat. Hist. Tin.," i., p. 98, pl. ii., fig. i. (1855); "Man.," ii., p. 434 (1859); H.-Sch., "Sys. Bearb.," v., p. 354 (1855); Frey, "Die Tineen," etc., p 381 (1856); "Linn. Ent.," xi., p. 408 (1857); Staud. and Wocke, "Cat.," p. 338 (1871); Nolck., "Lep. Fn. Estl.," p. 787 (1871); Mill., "Cat. Lep. Alp.-Mar.," p. 373 (1875); Hein. and Wocke, "Schmett. Deutsch.," p. 761 (1877); Sand, "Cat. Lep Auv.," p. 202 (1879); Bang-Haas, "N. H.Tids.," p. 218 (1881); Wallgrn., "Ent. Tids.," ii., p. 129

---

* We give the following synonymy for what it is worth: *Salicis*, Sta. = *diversa*, Glitz, *teste*, Hering, "Stett. Ent. Zeit.," lii., 221, no. 3061 (1891). *Obliquella*, Hein. = *diversa*, Glitz, *teste*, Glitz, "Stett. Ent. Zeit.," xlviii., p. 277 (1887). *Salicis*, Sta. = *obliquella*, Hein. = *diversa*, Glitz = *vimineticola*, Frey, *teste*, Hering, "Stett. Ent. Zeit.," liv., p. 117, no. 70 (1893).

(1881); Snellen, "De Vlinders," p. 999 (1882); Peyer., "Cat. Lep. Als.," 2nd Ed., ii., p. 165 (1882); Sorhagen, "Die Kleinschmett. Brandbg.," p. 308 (1886); Meyr., "Handbook," etc., p. 723 (1895). *Salicivorella*, Dbdy., "Cat.," p. 36 (1866); Porritt, "List. Yorks. Lepidop.," p. 171 (1886).

Original description.—*Nepticula salicis*, n. sp. Alis anticis fuscis, dilute luteo parum irroratis, postice saturatioribus et violaceo-tinctis, maculis duabus dilute luteis pone medium, fasciam obsoletam obliquam formantibus; capillis ferrugineis. Exp. al. 2½-3 lin. Head and face reddish-yellow. Palpi whitish. Antennæ fuscous, basal joint whitish. Anterior wings fuscous, slightly irrorated with pale luteous, posteriorly darker, and with a faint violet tinge; beyond the middle are two ill-defined, pale luteous spots, forming an indistinct oblique fascia; the costal spot is anterior to the dorsal spot; cilia pale luteous. Posterior wings pale grey, with pale grey cilia. Appears in May and August. The yellowish larva makes small tortuous mines, resembling blotches, in the leaves of sallows, in autumn and in July (Stainton, *Insecta Britannica*, p. 302).

Imago.—Head reddish-yellow. Anterior wings 5-6 mm.; fuscous with a yellowish tinge; apical portion darker, tinged with violet; an oblique, pale yellowish fascia (sometimes divided into two opposite spots) beyond the centre; cilia pale yellowish. Posterior wings and cilia pale grey.

Comparison of N. salicis with its allies.—*N. salicis* belongs to that section of the genus in which the anterior wings bear a single powdery pale fascia. It resembles, in this, *N. floslactella*, but the fascia is rather nearer the base, is more obliquely placed, and more slender. The apex of the wing is also darker, and the basal half is less coarsely scaled, and therefore seems smoother, and it never appears yellowish; besides, the legs are grey in this species, whereas in *N. floslactella* they are pale ochreous (Stainton).

Egg-laying.—The egg is deposited on the undersurface of the rough leaves of *Salix cinerea* and *S. caprea*, near a rib, and almost concealed in the down that covers the underside of the leaf.

Mine.—The mine commences with a short visceriform track, soon becomes more open, and ends in a complete blotch. The excrement in the early part of the mine is reddish-brown, in the blotch dark grey, forming a rather broad continuous streak (Stainton). Wood observes that the larva feeds on almost every species of *Salix*, and the mines vary according to the physical differences between the leaves of the various plants. In the small crumpled leaf of *S. aurita*, the mine is condensed into a verminform gallery; in the large leaf of *S. caprea*, the gallery, almost filled with frass, is either fairly straight (following the line of a rib), or more or less contorted, or, on the other hand, it may dilate towards its termination into a blotch; in the smooth-leaved *S. alba* and *S. russelliana*, it is invariably a blotch. (The mine in *S. alba* may possibly be that of *N. vimineticola*). Nolcken notes a great similarity between the mines of *N. salicis* and *N. myrtillella*. On "Wollweiden" the former makes only a small blotch of pale yellowish colour, the windings raised somewhat above the surface of the leaf, on other species of willow (so far as can be observed from dried leaves), the skin is not raised, and the mine is more greenish in tint. These differences are due to the dissimilar character of the leaves. The mode of deposition of the frass appears just as in the preceding species (*N. myrtillella*). Sometimes the mine forms a fine thread on the margin of the leaf; when it originates in the centre, it has a closely twisted commencement, which is often absorbed later by the blotch.

Larva.—Length 2 lines; amber-coloured, shining, the dorsal vessel a little darker; the head brown, and two brown lobes show through the prothorax (Stainton). Nolcken describes the larva as being of a "faint, honey-yellow tint, with very transparent, pale brown head, and darker mouth-parts and sutures; the intestinal canal greenish; on the ventral surface a row of indistinct lozenge-shaped spots, very small, and joined together." Wood notes that "the prothoracic markings (the equivalents of the two halves of a prothoracic plate) are blackish, and, lying more or less over the posterior lobes, help to give a specially dark appearance to the back part of the head."

Cocoon.—The cocoons examined (8) average 3 mm. in length, and 2 mm. in width, variable in shape, roughly oval in outline, but with one end distinctly broader than the other, the long sides also being slightly hollowed out in some specimens. There is no very clearly defined rim, although the edge thins off and is distinctly crenate, the upper portion is considerably arched, the surface rather rough and covered with a thin coating of loose flossy silk, the colour varying from pale straw yellow to a deep yellow inclining to orange. The empty pupa-case projects from the wider end, and is quite transparent and colourless, shiny and apparently very delicate. [Description made July 20th, 1898, under a two-thirds lens, from cocoons sent by Mr. W. H. B. Fletcher.] To the naked eye the darker cocoons are pale brown in hue, the rim appearing yellowish on the edge. The lighter cocoons are entirely pale yellowish. Cocoons (9) sent by Dr. Wood also average 3 mm. in length and 2 mm. in width, and are also variable in shape, the more regular ones forming an almost perfect oval in outline. Stainton notes the cocoon as "brownish-ochreous, rather shining, somewhat mussel-shaped." Frey describes it as "dark red-brown, somewhat flattened, smooth, forming a longish oval." Hind says it is "rather large, brown in colour, with the broad end yellowish."

Comparison of cocoon of N. salicis with that of N. vimineticola.—The cocoon of *N. vimineticola* is markedly smaller (and especially narrower) than that of *N. salicis*; it is much thicker at its narrow end; dark brown (almost mahogany-brown) in colour, whilst that of *N. salicis* is pale yellowish or orange in tint; the cocoon of *N. vimineticola* is also much more thickly covered with flossy silk than is that of *N. salicis*.

Food-plants.—*Salix cinerea*, *S. caprea*, *S. aurita*, *? S. russelliana.*

Time of appearance.—The species is double-brooded, the imago appearing in April-May and July-August, from larvæ that feed up in September-October and July respectively. Millière records it as appearing in April, at Cannes. Atmore says that it is one of the earliest species to appear, being out at King's Lynn, usually by the last week of April, or first week of May, and Hodgkinson records the breeding of it on April 13th, 1887, at Preston. Reuter found it on May 13th, 1876, in the I. of Aland, yet Chapman, at Redhill, did not breed the insect from mines of the previous autumn until June 7th-12th, 1898. Frey records the second brood as being only partial nr. Zürich, in July. Stainton captured imagines on June 5th, 1849 (between 7-8.30 p.m.), at Torwood, and June 10th, 1878, at Lewisham. He also bred imagines on March 12th, April 16th, August 1st, 1852, March 8th, 1853, March 14th, April 9th-20th, 1854, from Lewisham larvæ, April 8th, 1854, from Dawlish, and June 25th, 1854, from Box Hill. Threlfall bred imagines June 5th-6th, 1877, from mines obtained at Windermere on October 6th, 1876. Bower notes mines as occurring commonly at Eltham on October 25th, 1892, and Durrant the breeding of imagines from February 13th-April 5th, 1866, by Schleich.

Localities.—Aberdeen: Pitcaple and district (Reid). Cambridge: Cambridge, Fulbourn, Ditton (Farren). Cheshire: Birkenhead (Stainton), Bowdon (Edleston). Devon: Dawlish (Stainton). Dorset: Portland (Richardson), Glanvilles Wootton (Cambridge), Weymouth (Richardson), Purbeck (Bankes). Durham: Darlington (Sang). Essex: Wickham Bishops (Cansdale). Gloucester: Bristol (Stainton). Hereford: Tarrington (Wood). Kent: Lewisham (Stainton), Eltham (Bower), Chattenden (Tutt), Southborough (Blackburne-Maze). Lanark: nr. Glasgow (King). Lancashire: Manchester (Stainton), Chat Moss (Chappell), Grange (Hodgkinson), Preston (Threlfall), Wirrall (Brockholes). Leicester: Market Harborough (Matthews). Norfolk: Ranworth (Barrett), King's Lynn, common (Atmore) Perthshire: Torwood (Stainton). Somerset: Clevedon (Mason). Surrey: Box Hill (Stainton), Redhill (Chapman), Haslemere (Barrett). Sussex: common in the county, *e.g.*, Goring Woods, etc. (Fletcher), Guestling (Bloomfield). Westmorland: Windermere (Threlfall). Yorkshire: Scarborough (Stainton), Doncaster (Warren), Richmond and Harrogate (Sang), York (Hind).

Distribution.—Denmark; several localities in north-east Zealand (Bang-Haas). France: Cannes (Millière), Nohaut, Indre (Sand). Germany: generally distributed (Heinemann and Wocke), Alsace (Peyerimhoff). Berlin, Friedland, Stettin, Hamburg (Sorhagen), Frankfort-on-the-Main (Heyden). Netherlands: Friedland, N. Brabant, S. Holland (Snellen). Russia: Pichtendahl (Nolcken), Porgas nr. Abo, Aland (Reuter). Scandinavia: Scania (Wallengren). Switzerland: nr. Zürich (Frey).

NEPTICULA VIMINETICOLA, Frey.

Synonymy.—Species: *Vimineticola*, Frey, "Die Tineen," etc., p. 382 (1856); "Linn. Ent.," xi, p. 409 (1857); Staud. and Wocke, "Cat.," p 339 (1871); Hein. and Wocke, "Schmett. Deutsch.," p. 761 (1877); Snellen, "De Vlinders," etc., p. 1001 (1882). *Salicis*, Meyr., "Handbook," etc., p. 723, in part (1895).

Original description.—*Nepticula vimineticola*, n. sp. Capillis rufo-ochraceis, antennarum conchula flavido-alba; alis anter. grossiuscule squamatis, fuscis, dimidio basali squamis luteis crebro consperso, fascia obliqua lutea obsoletissima pone medium, apice fusco, ciliis dilute luteis; tarsis posticis cinereis. $2\frac{3}{4}$—$2\frac{1}{2}'''$. Ich habe an 40 Exemplare dieser *Nepticula* erzogen, welche ich als besondere Spezies zu betrachten sehr geneigt bin, da die Differenzen gegenüber der an Trauer- und Wollweiden minirenden *N. salicis* allzugross sind, um sie damit zu verbinden, und ich auch keine Uebergänge erhielt. *N. vimineticola* kommt den bräunlichen, hellen Exemplaren der *N. floslactella* am nächsten, ist aber etwas kurzflügliger, mit röthlicheren Scheitelhaaren und stärker gelb gefärbten Franzen versehen. Diese, lebhafter gefärbt als bei irgend einer anderen mir bekannten Spezies, dienen wohl am leichtesten zur Erkennung der Art. Der Schopf und das Gesicht lebhaft rothgelb; Palpen weisslich. Die Augendeckel gelblich weiss, ziemlich ansehnlich. Die Fühlergeisel tief braunschwarz. Der Rückenschild braun, mit lehmgelben Schüppchen gemischt. Der Hinterleib schwärzlich; die Beine lichtgrau. Die Vorderflügel zeigen eine eigenthümliche, übrigens sehr grobe Beschuppung. Ihre Grundfarbe ist ein dunkles Braun, welches aber nur an der, nicht oder kaum violett schimmernden, Spitze rein und dunkel zu Tage tritt, dagegen an der Wurzelhälfte durch aufgelegte lehmgelbe Schüppchen bedeutend aufgehellt wird Ist dieser Belag sehr stark, so wird die ganze Wurzelhälfte, geradezu lehmgelb. Die schief stehende Binde erscheint hinter der Mitte wie bei *N. salicis* und ist ebenfalls schief und schmal. Sie ist aber stark lehmgelb, niemals weisslich, nach aussen schärfer abgesetzt als nach innen, immer aber sehr wenig deutlich. Ist die Wurzelhälfte sehr hell, so verfliesst sie nach einwärts ganz mit dieser, und wir haben eine *Nepticula* mit einer bis über die Hälfte gehenden, schief und scharf von der dunkeln Flügelspitze abgesetzten Beschuppung. Die Franzen an der Spitze des Flügels grau; dann auffalend lehmgelb, um am Afterwinkel wieder einen grauen Ton anzunehmen. Hinterflügel und ihre Franzen grau. Die Raupe minirt in zwei Generationen an *Salix viminalis.* Sie ist lebhaft gelb. Die Mine ist ein neben der Mittelrippe verlaufender, schmaler Gang, sehr wenig gewunden und mit dem dunkelbraunen Kothe in breiter, zusammenhängenden Linie dicht erfüllt. Sie ist darum schwer zu sehen. Der Cocon heller braun als bei *N. salicis.* Bei Zürich nicht selten; auch im Juli gefangen (Frey, *Die Tineen und Pterophoren der Schweiz*, pp. 382-383).

Imago.—Head reddish-ochreous. Anterior wings 4-5 mm.; fuscous, the basal half with scattered yellowish scales; a narrow, oblique, very pale yellow fascia beyond the middle; apex fuscous tinged very slightly with violet; cilia grey, with the outer parts yellowish. Posterior wings and their cilia grey.

Variation.—Warren records that among a number of imagines bred in 1883 from *Salix alba*, there was one very beautiful aberration with the fore-wings white from the base to the external margin of the pale fascia. Warren refers the species to *N. salicis*, but *N. vimineticola* had not then been differentiated as British.

Comparison of N. vimineticola with N. floslactella and N. salicis.—*N. vimineticola* comes nearest to pale brownish specimens of *N. floslactella*, but is always narrower winged. The head is conspicuously reddish, and the fore-wings have a distinct yellow fringe, of a deeper and brighter tint than I have noticed in any other Nepticulid species, and which is very characteristic. From *N. salicis* the colour of the fore-wings and the great indistinctness of the transverse band, distinguish it (Frey). Besides the difference in the cocoons and the position in which the egg is laid, *N. vimineticola* appears to be a shade smaller and looks a darker insect than *N. salicis*, when a series is seen in a mass (Fletcher).

Egg-laying.—Wood notes, in his account of the egg-laying of *N. salicis*, that "if *Salix alba* be chosen the egg is laid on the upper surface of the leaves; probably this side is chosen because the covering of the underside of the leaves is not only extremely dense, but is also closely brushed down upon the surface, whilst on the upper side the hairs are not so thick." Of six mines in *S. alba*, sent by Fletcher as those of *N. vimineticola*, the egg is placed on the under side in five instances, and on the upper side in one only. The egg is very small, oval, and filled with black frass.

Mine.—The mine runs conspicuously, as far as the midrib, as a narrow gallery, making very small convolutions, and with the dark brown frass forming a broad, conspicuous, dense stripe almost filling it. The mine is on that account sure to attract attention (Frey). One of six mines examined (from Mr. Fletcher), commences at the midrib, has a straight and comparatively broad beginning, filled with black frass, then makes two small sharply bent curves, in which the frass is central and the margins pale, the gallery gradually expanding into an oval blotch, stretching for 18 mm. along the margin of the leaf, and, with the frass, forming a central line. Another commences on a lateral vein, by the side of which it runs a short distance, turns back sharply on itself almost to its point of origin, then returns again, zigzags over a lateral vein, and at last widens similarly to the last. Four others form irregularly oval blotches about 12 mm. × 6 mm., the frass collected near the base in a somewhat irregular heap, due to the early portions of the mine being bent back closely on themselves so that the parenchyma between is all eaten; two of these commence on the outer margin, and are directed towards the midrib, the other two commence near the midrib, and extend toward the outer margin.

Larva.—Frey describes the larva as "bright yellow."

Cocoon.—The cocoons (8) examined average about 2·75 mm. in length, and 1·25 mm. in width, forming roughly a long oval in outline, of which one end is broader than the other, the broad end being distinctly thinner than any other portion of the cocoon. There is no trace of a rim (except round the front edge of the thinner end); the arched portion rises abruptly from the edge of the cocoon on the other three sides, being very thick at the narrower end. The cocoon is very dark brown in colour, shiny, and thickly covered with loose flossy silk, which appears rather paler than the body of the cocoon. The pupa-case protrudes from the wider end, is colourless and transparent. [Described July 20th, 1898, under a two-thirds lens, from cocoons sent by Mr. W. H. B. Fletcher.] The following note by Warren probably refers to this species. He writes: "In the month of July, 1883, while examining the leaves of *Salix alba*, I noticed at the extreme tip of a leaf a brown *Nepticula* cocoon, and lower down, in the same leaf, the empty mine. On further search I discovered 20 or 30 such cocoons, all but one placed at the tip of a leaf, not always the same leaf as that in which the larva had fed up, but occasionally on an adjacent one. The sole exception had spun up on a midrib close to the leafstalk" (*E. M. M.*, xx., p. 187).

Food-plants.—*Salix alba*. *Salix viminalis* (Frey).

Time of appearance.—The species is double-brooded according to Frey, occurring in May and July, from larvæ found feeding in June and August-September respectively. Edleston records having found larvæ of this species near Manchester, in osiers, in 1856. Reuter found imagines on May 13th, 1876, in the I. of Aland.

Localities.—? Cambridge: Cambridge (Warren). ? Hereford: Tarrington (Wood). Lancashire: nr. Manchester (Edleston). Sussex: Abbott's Wood, Adur and Arun valleys (Fletcher).

Distribution.—Netherlands: Rotterdam, and many other places in North and South Holland, Arnhem, Gelderland (Snellen). Russia: I. of Aland (Reuter). Switzerland: Zürich (Frey), Turicum (Wocke).

NEPTICULA OBLIQUELLA, Hein. (? var. præc. sp.)

SYNONYMY.—Species: *Obliquella*, Hein., "Wien. Ent. Monats.," vi., p. 316 (1862); Hein. and Sta., "Zool.," xxi., p. 8382 (1863); Staud. and Wocke, "Cat.," p. 338 (1871); Glitz, "Stett. Ent. Zeit.," xlviii., p. 277 (1887). *Diversa*, Glitz, "Stett. Ent. Zeit.," xxxiii., pp. 24-25 (1872); Staud. and Wocke, "Cat.," p. 339 (1871); Hein. and Wocke, "Schmett. Deutsch.," p. 761 (1877); Frey, "Lep. der Schweiz," p. 424 (1880); Bang-Haas, "N. H. Tidsk.," p. 218 (1881); Sorhagen, "Die Kleinschmett. Brandbg.," p. 308 (1886); Hering, "Stett. Ent. Zeit.," lii., p. 221 (1891); Hutchinson, "List of Heref. Lepidop.," p. 16 (? 1892). *Vimineticola*, Snellen, "De Vlinders," etc., p. 1001, in part (1882). *Salicis*, Meyr., "Handbook," etc., p. 723, in part (1895).

ORIGINAL DESCRIPTION.—*Nepticula obliquella.* Capillis ochraceis, antennarum conchula parva flavida; alis anterioribus fuscis, post medium grosse squamatis, nigris, fascia media obliqua in plica fracta albida, vix sericeo-nitente; ciliis post lineam nigram albis. Exp. al. 2½ lin. Diese Art kommt mit denen der vorigen Abtheilung (*N. arcuatella*, etc.) in der ganz eben so gestellten und geformten Binde überein, unterscheidet sich aber durch die Farbe und den mangelnden Metallglanz derselben; bei *N. tityrella* und deren Verwandten steht die Binde hinter der Mitte und haben die Fransen keine Theilungslinie; in der Gruppe von *N. salicis* sind die Vorderflügel auch vor der Binde grobschuppiger und die Binde steht gleichfalls weiter saumwärts. Die Kopfhaare ockergelb, Nackenschöpfe und Augendeckel etwas bleicher, die Fühlergeissel hellgrau, die Beine licht schwärzlich grau. Die Vorderflügel sind schmal, gleichbreit, vor der Binde ziemlich feinschuppig, graubraun, dahinter mit groben schwarzen Schuppen dicht bedeckt. Die Binde ist schmal und zieht aus dem Vorderrande noch etwas vor dessen Mitte schräg bis zur Falte; hier verbindet sie sich mit einem Fleckchen, das aus dem Innenrande hinter der Mitte gleichfalls schräg nach aussen gerichtet ist, und bildet mit demselben einen nahezu rechten Winkel, bisweilen ist sie statt dessen von der Falte ab dreieckig erweitert. Von Farbe ist dieselbe weisslich, sehr wenig in's Gelb ziehend, mit schwachem Seidenglanze. Die Fransen sind bis zur Theilungslinie gleichmässig dunkel beschuppt, dahinter weisslich, am Innenwinkel grau. Die Hinterflügel nebst den Fransen hell bräunlich grau. Ich fing einige Stücke im Mai an Waldrändern (Heinemann, *Wiener Entom. Monatschrift*, vi., pp. 316-317).

IMAGO.—Head ochreous. Anterior wings 5 mm.; greyish-brown, covered with coarse black scales beyond the fascia; central transverse fascia narrow, whitish-yellow, slightly lustrous, angulated centrally; cilia dark to the divisional line, whitish beyond. Posterior wings and cilia pale fuscous.

DESCRIPTION OF N. DIVERSA.—*Nepticula diversa.* Unter *N. salicis*, Sta., waren bisher 2 verschiedene Arten vereinigt, wovon die eine (*salicis*) als Raupe auf Wollweiden, *Salix caprea*, etc., die andere (*diversa*) auf schmalblättrigen glatten Weiden, *Salix alba*, etc., lebt. Der Unterschied zwischen beiden Arten besteht darin, dass bei *N. diversa* die Grundfarbe der Vorderflügel nicht violett, sondern schwarz, die Binde schmäler und nicht wie bei *N. salicis* oft in 2 Gegenflecke aufgelöst ist, hauptsächlich aber, dass die schwarzen Schuppen auf der Wurzel der Franzen regelmässiger als bei *N. salicis* liegen und mit ihrem Ende eine gleichmässige, stärker gekrümmte Theilungslinie bilden, während bei *N. salicis* die Schuppen unregelmässiger stehen, nach aussen ziemlich gerade abgestutzt sind und einzeln in die äussere Hälfte

hinaustreten [Glitz, *Stett. Ent. Zeitung*, xxxiii., pp. 24-25 (1872)]. Glitz himself afterwards referred his *N. diversa* to *N. obliquella*, Hein., and gives the latter name priority. Martini remarks that "*N. diversa-obliquella* is an ill-defined species, and not to be separated with certainty from *N. salicis*, Sta. The differences in the mines appear to be due to the greater thickness of the leaves of *Salix cinerea* and *S. caprea*" (*Stett. Ent. Zeit.*, liv., p. 117).

N. OBLIQUELLA (DIVERSA) AS A BRITISH SPECIES.—Of this species, Wood says: "*N. diversa* is the one species that I take here that I know next to nothing about. I bred a single specimen some years ago and, if my memory serves me correctly, the mine was a wide gallery with a narrow frass-track. It was not rare one season, rather early in autumn, but I have been on the look out for it since to no purpose" (*in litt.*, June 3rd, 1898).

COMPARISON OF N. OBLIQUELLA WITH ITS ALLIES.—*N. obliquella* agrees with the species in the preceding section (*N. angulifasciella*, etc.), in the fascia being quite similarly placed, and of similar form, but differs in the colour of the fascia, and its want of metallic lustre. In *N. tityrella* and its allies, the fascia is placed beyond the middle of the wing, and the cilia show no divisional line. In the group containing *N. salicis*, the anterior wings are also more coarsely scaled before the fascia, which is placed more posteriorly (Heinemann). *N. diversa* (*obliquella*) differs from *N. salicis* and *N. myrtillella*, in having a less bluish tint on the fore-wings, and in having a narrower transverse band. From the former it differs also in the more regular arrangement of the black scales along the divisional line running through the cilia; from *N. myrtillella* in having the basal area of the fore-wings, the transverse band and the cilia, more yellowish in colour (Heinemann and Wocke).

MINE.—The mine is placed near the mid-rib, forming a slender slightly tortuous gallery, filled with dense brown frass, and is, on that account, a little striking (Sorhagen).

COCOON.—Brown (Sorhagen).

FOOD-PLANTS.—*Salix alba*, *S. viminalis*. Smooth-leaved willows (Heinemann and Wocke).

TIME OF APPEARANCE.—Sorhagen gives it as double-brooded, the larvæ to be found in July and October in the leaves of *Salix viminalis*. Heinemann found imagines in May, on the edges of woods near Brunswick. Hering gives the larva as occurring in September in Friedland.

LOCALITY.—HEREFORD: Tarrington (Wood).

DISTRIBUTION.—Denmark: Copenhagen (Bang-Haas). Germany: generally distributed (Heinemann and Wocke), Friedland, nr. Breslau (Sorhagen), north-east Germany (Wocke), Alt Damm (Hering). Switzerland: nr. Zürich (Frey).

NEPTICULA FLOSLACTELLA, Haworth.

SYNONYMY.—Species: *Floslactella*, Haw., "Lep. Brit.," p. 585 (1828); Stphs., "Illus.," iv., p. 268 (1835); Sta., "Cat. Brit. Tin.," p. 29 (1849); "Ins. Brit.," p. 301 (1854); "Nat. Hist. Tineina," i., p. 106, pl. ii., fig. 2 (1855); "Man.," ii., p. 434 (1859); H.-Sch., "Sys. Bearb.," v., p. 355 (1855); Frey, "Die Tineen," etc., p. 383 (1856); "Linn. Ent.," xi, p. 411; Staud. and Wocke, "Cat.," p. 339 (1871); Nolck., "Lep. Fn. Est.," p. 789 (1871); Hein. and Wocke, "Schmett. Deutsch.," p. 762 (1877): Sand, "Cat. Lep. Auv.," p. 202 (1879); Bang-Haas, "N. H. Tidsk.," p. 218 (1881); Wallgrn., "Ent. Tids.," ii., p. 130 (1881); Peyer., "Cat. Lep. Als.," 2nd Ed., ii., p. 166 (1882); Snellen, "De Vlinders," p. 1000 (1882); Sorhagen, "Die Kleinschmett. Brandbg.," p. 308 (1886); Meyrick, "Handbook," etc., pp. 723-724 (1895).

Original description.—*Tinea floslactella* (The cream Pygmy). Alis pallide flavescentibus postice fasciaque medio violaceo-atris. Expansio alarum 3 lin. Species agilissima. Caput ferrugineum. Alæ anticæ pallidisime flavescentes, medio, maculâ maximâ fasciæformi irregulari fere atrâ; alterâque terminali subrotundâ atro-violaceâ, a costâ ad marginem tenuiorem: ciliis albido-flavescentibus. Posticæ subulatæ fusco-plumbeæ sericeæ utrinque ciliis plumbeis altissimis ut in affinibus. Habitat in Com. Surrey prope Londinum. Imago sepibus sylvaticis f. Mai (Haworth, *Lepidoptera Britannica*, p. 585).

Imago.—Head bright yellowish. Anterior wings 5-6 mm.; fuscous much dusted with yellowish towards the base; beyond the middle is a rather oblique, yellowish fascia; the apical portion of the wing is entirely fuscous with a faint violet tinge: cilia whitish-yellow. Posterior wings and cilia pale grey.

Variation.—This species possesses a certain tendency to vary. Some specimens have the fore-wings of a tolerably blackish hue; others, owing to the development of the yellow-brown scales, especially at the base of the fore-wings, have a much paler and browner tint. It is remarkable that the specimens bred from *Corylus* are much more yellow than those from *Carpinus*, which are blacker in appearance. One might suppose them to be different species were not the larvæ and mines alike (Frey). Stainton notes that some specimens have "the anterior wings yellowish, irrorated with a few fuscous scales towards the base and a fuscous fascia a little before the middle. Others have the entire basal half of the anterior wings fuscous." He further says that "sometimes the medial dark fascia is omitted, the first two-thirds of the wing being entirely yellowish." Haworth notes a form as: "*β*. Alæ anticæ absque fascia media irregulari atra."

Comparison of N. floslactella with N. salicis.—The best distinguishing mark between *N. floslactella* and *N. salicis* is the much broader, perpendicular band. The hind-legs of *N. floslactella* have yellowish-grey tarsi, whilst those of *N. salicis* are unicolorous grey (Frey). *N. salicis* has the anterior wings more glossy and less coarsely scaled; the pale fascia a little nearer to the base, rather more obliquely placed, and the apical portion of the wing is darker in *N. salicis* than in *N. floslactella* (Stainton).

Egg-laying.—The egg is laid on the underside of a leaf of nut or hornbeam, close to a rib.

Mine.—The mine forms an irregular wavy gallery; in the first part the excrement forms a line occupying almost the whole width; then, for some distance, it forms an irregular series of blackish grains, still occupying almost the whole width of the mine; in the last third, the frass forms a central row of black grains, with a considerable whitish margin on either side. The larva leaves the mine by the upper surface of the leaf (Stainton).

Larva.—Length nearly two lines; very pale amber, with the dorsal vessel greenish; head light brown, with the mouth and margins darker; the prothorax pale brownish, with the two darker hinder lobes of the head showing through, behind which, in the centre, is a quadrate black spot showing through (Stainton). Frey describes the larva as "very pale sulphur-yellow, with the dark green alimentary canal showing through the skin; the head shiny brown, being especially dark towards the hinder part." The larva mines with the dorsum uppermost (Wood).

Cocoon.—The cocoons (5) examined average almost 3 mm. in length, and 2 mm. in width. They are oval in outline, rather wider at one end than the other, the pupa emerging from the wider end. The cocoon is of a pale straw colour, and covered with an exceedingly thick outer coating of loose flossy silk, reminding one (under the lens) of a cocoon of *Bombyx mori*. [Described under a two-thirds lens, on July 12th, 1898, from cocoons sent by Dr. Wood.] Cocoons sent by Fletcher were spun up on the leaves of the food-plant, probably the usual method in nature. Stainton notes the pupa as being "of moderate size, rather egg-shaped, whitish-yellow in colour, the outer portion remaining loose and flossy." Sorhagen adds that "the cocoons are yellowish when spun on *Corylus*, whitish when on *Carpinus*."

Pupa.—The empty pupa-case is quite transparent, without any darker markings, and protrudes as far as the third abdominal segment. There is a considerable amount of iridescence on the pupal skin, and each of the abdominal segments 2-6 presents a raised dorsal belt, along which is a plentiful supply of brown hooklets, large and well-developed compared with the size of the pupa, by means of which undoubtedly the pupa is able to emerge before the appearance of the imago.

Food-plants.—*Corylus avellana* and *Carpinus betulus*. One leaf sometimes contains as many as twelve larvæ (Hind).

Time of appearance.—The insect is double-brooded, the imagines appearing in May and August, from larvæ feeding in September-October and July respectively. Peyerimhoff notes the imago in April, in Alsace, and Sand in May, at Nohaut, from larvæ found in November. Frey notes a first brood at Zürich in May, with a second brood, at the end of July-August. Stainton captured imagines May 21st, 1851, at Beckenham, August 2nd, 1851. July 23rd-26th, 1852, May 17th, 1855, June 17th, 1855, May 23rd, 1881, at Lewisham. He also bred the species on March 22nd, May 9th, August 10th, 13th, 14th, 1853, February 19th, March 30th, April 1st, 1854, March 9th, 25th, 26th and April 1st, 1855, all at Lewisham. Threlfall bred imagines from April 11th-30th, 1878, from larvæ taken at Witherslack, October 6th, 1877. He also captured imagines at the same locality on May 14th, 1878. Nolcken records mines as early as August 3rd, in Rotsiküll, nr. Pichtendahl. Mines were common also on nut on October 6th, 1890, at Darenth, on October 15th, 1890, on hornbeam, at Bexley, on October 25th, 1892, on nut, at Eltham (Bower).

Localities.—Berks: Reading (Hamm). Cheshire: Birkenhead (Stainton), Derby: Burton (Sang). Dorset: Bloxworth (Cambridge), Purbeck (Bankes), Weymouth (Richardson), Glanvilles Wootton (Dale). Durham: Darlington (Sang). Essex: Epping (Stainton), Wickham Bishops (Cansdale). Gloucester: Bristol (Stainton). Hereford: Tarrington (Wood). Kent: Tenterden, Lewisham, Pembury (Stainton), Croydon (Elisha), Darenth, Bexley, Eltham (Bower), Chattenden (Tutt). Lanark: Langside, Kenmuir Bank (King). Lancashire: common everywhere in the county (Ellis), Manchester (Stainton). Leicester: Market Harboro' (Matthews). Linlithgow: Drumshoreland (Logan). Norfolk: Merton, Horstead (Barrett). Northumberland: Newcastle (Stainton). Somerset: Clevedon (Mason). Surrey: Haslemere (Barrett). Sussex: common in the county, Goring Woods, etc. (Fletcher), Lewes (Stainton), Guestling (Bloomfield).

Westmorland: Windermere (Hodgkinson), Witherslack (Threlfall). York: Scarborough (Stainton), York (Hind), Doncaster (Corbett), Harrogate, Richmond (Sang). Scotland: common, to the Clyde (Meyrick).

Distribution.—Denmark: not rare in north-east Zealand (Bang-Haas). France: Nohaut, Indre (Sand). Germany: generally distributed (Heinemann and Wocke), Alsace (Peyerimhoff), Berlin, Friedland, Stettin, Hamburg (Sorhagen), Frankfort-on-the-Main (Schmid). Netherlands: Gravenhage, Overijssel, N. Brabant (Snellen). Scandinavia: Blekinge (Wallengren). Switzerland: nr. Zürich (Frey).

Group VI.—Cilia of the anterior wings with a distinct or indicated divisional line, beyond which they are abruptly pale. The anterior wings coarsely scaled with two whitish opposite spots (sometimes tending to form an indistinct, non-metallic central fascia) or without any paler markings.

NEPTICULA ARGYROPEZA, Zeller.

Synonymy.—Species: *Argyropeza*, Zeller, "Isis.," 1839, p. 215; "Linn. Ent.," iii., p. 320 (in part) (1848); Tengström, "Bidrag Fin. Fjär.-Fauna," p. 152 (1847); Frey, "Linn. Ent.," xi., pp. 398-400 (1857); Sta., "Nat. Hist. Tin.," vii., p. 188 (except descr. imago) (1862); "Man.," ii., p. 433 (except descr. imago) (1859); Staud. and Wocke, "Cat.," p. 339, no. 3076 (1871); Nolck., "Lep. Fn. Est.," p. 795 (1871); Hein. and Wocke, "Schmett. Deutsch.," p. 768 (1877); Sand, "Cat. Lep. Auv.," p. 202 (1879); Wallgrn., "Ent. Tids.," ii., p. 131 (1881); Erschoff, "Trudy Russ. Ent. Soc.," xii., p. 221 (1881); Bang-Haas, "N. H. Tids.," p. 218 (1881); Peyer., "Cat. Lep. Als.," 2nd Ed., ii., p. 167 (1882); Curò, "Bull. Soc. Ent. Ital.," xv., p. 109 (1883); Fritsche (*teste* Stainton), "Ent. Mo. Mag.," xxii., p. 237 (1886); Sorhagen, "Die Kleinschmett. Brandbg.," p. 311 (1886); *nec*, H.-Sch., "Sys. Bearb.," p. 930 (1855). *Apicella*, Sta., "Ins. Brit.," p. 300 (1854); "Man.," ii., p. 433 (1859); Heyd., "Stett. Ent. Zeit.," xxvi., p. 381 (1865); Heyd. and Sta., "Ent. Ann.," 1868, pp. 50-51; Staud. and Wocke, "Cat.," p. 339, no. 3077 (1871); Frey, "Lep. der Schweiz," p. 425 (1880); Sang, "Ent. Mo. Mag.," xxii., pp. 236-237 (1886); Meyr., "Handbook," etc., p. 726 (1895). [*nec Argyropeza*, Heyd., "Stett. Ent. Zeit.," xxii., p. 40 (1861); *nec*, Heyd. and Sta., "Ent. Ann.," 1868, p. 50, which = *N. turbidella*]. *Argyropezella*, Vaughan, "Ent. Week. Int.," vol. vi., p. 14 (1859); Porritt, "List Yorks. Lep.," p. 171 (1886). *Sericopeza*, Wocke, "Stett. Ent. Zeit.," xxvi., p. 106 (1865).

Original description.—8. *Argyropeza*, Z. (*Argyropedella, in litt.*).—Grösse der vorigen (*N. argentipedella*); die Vorderflügel zugerundet, etwas glänzend, grob schwärzlich beschuppt, nach hinten violett; 2 weissliche Gegenflecke hinter der Mitte; die Kopfhaare rostgelb; die Fühler bräunlich mit weisslichen Augendeckeln.—Bei Glogau im May vorzüglich an Espenstämmen, sehr gemein (Zeller, *Isis*, 1839, p. 215). Ten years afterwards, Zeller diagnosed the species as follows: Alis anterioribus grosse nigricanti-squamatis, postice violascenti-subnitidulis, apice rotundato, albido-ciliato, maculis duabus mediis oppositis albidis; capillis ferrugineis; conchula exalbida. Vorderflügel hinten auscheinend erweitert, indem auf den Franzen um die Spitzen dunkle Schuppen strahlenförmig liegen, grobschuppig, wenig glänzend. Die Schuppen an der Basis hell, am Ende dunkelbraun, sehr wenig violettlich schimmernd, am meisten noch um die Spitze, wo sie gedrängter stehen. Fehlen einzelne Schuppen, so treten die weisslichen Wurzeln der benachbarten Schuppen fleckenartig hervor. An der Mitte des Vorderrandes und am Anfange der Innenrandfranzen liegt je ein weisslicher, nicht scharf begrenzter Fleck, mit den Spitzen einander zugekehrt, mit denen sie bisweilen fest verbunden sind, ziemlich senkrecht unter einander. Beim Weibchen sind diese Flecke kleiner, gelblicher, schärfer. Die äussersten um die Spitze herum auf den Franzen liegenden Schuppen sind lang, und ihre dunkeln Enden bilden einen dunkeln Ring um die Spitze hinter einem lichteren Ringe. Die Franzen dahinter sind hellgrau, kaum ein wenig gelblich schillernd. Hinterflügel heller grau, als die einfarbige Unterseite der Vorderflügel, deren Franzen so hell sind, wie auf der Oberseite. Das Weibchen (mein einzelnes Exemplar) ist auf den Vorderflügeln dunkler, weniger glänzend und die Gegenflecke gelblich und schärfer umgrenzt (*Linnaea Entomologica*, iii., pp. 320-322).

Imago.—Head ferruginous. Anterior wings 6-7 mm.; scales blackish, paler at their bases; bluish-black towards the apex; two opposite whitish spots near middle of wing, one (small) on costa, another (larger) on inner margin; cilia grey, long, with silvery white tips. Posterior wings pale grey, the cilia paler.

Comparison of N. argyropeza with N. subapicella.—The imago of *N. argyropeza*, Zell. (= *apicella*, Sta.), has the costal and dorsal spots exactly opposite. The imago of *N. subapicella*, Sta. (= *argyropeza*, Sta.) has the costal spot anterior to the dorsal spot (*i.e.*, the costal spot is nearer to the base of the wing than in the former) (Stainton).

Egg-laying.—The egg is laid upon the stalk of an aspen leaf, "about a quarter of an inch from its junction with the leaf" (Vaughan); "at the end of the leaf-stalk" (Heyden). Nolcken has found as many as four eggs on one petiole, but never more than two mines in one leaf.

Mine.—A small swelling is formed where the young larva bores into the petiole at the foot of an aspen leaf. The larva then mines up the petiole to the foot of the leaf, and forms a wedge-shaped blotch at the base of the leaf. Vaughan notes that the young larva, after penetrating the stem, enters the leaf at the midrib, and mines the upper cuticle, rarely passing through a rib, but completely devouring all the substance between the middle and one side rib, thus forming a wedge-shaped mine with the excrement irregularly scattered. Heyden says that the portion of the leaf-stalk mined is flattened sideways, and tolerably thick, the mine forming an elongate black-brown blotch, that widens anteriorly, and is sometimes five lines long, and placed between the edge of the leaf and first lateral rib, or between the latter and the midrib. Nolcken says that the mine is always between two ribs, and bounded with a curve on the outer edge, the frass being arranged irregularly, and collected in little heaps. Heyden notes that there is often a mine on either side of the midrib. Wood says that "to see an aspen tree with nearly every leaf of a pure yellow, save for a bold splash of vivid green striking across from stalk to margin, is an extraordinary sight, and one that can scarcely fail to attract attention." Sorhagen notes that "the black frass is deposited in the mine in two parallel streaks along each rib, the small empty space between which looks like a continuation of the midrib."

Larva.—Length $2\frac{1}{4}$ lines. Pale amber, the dorsal vessel greenish or brownish-green, head pale brown, darker at the side, prothorax greyish above, posteriorly with two reddish-brown subcutaneous patches, forming a horseshoe-like mark. On the underside of the prothorax is a dark brown subcutaneous patch, posteriorly black; some wedge-shaped yellowish-brown marks are visible on the underside of the third, fourth, fifth and twelfth segments (Stainton).

Nolcken describes the larva as "translucent pale yellow, at times somewhat darker-coloured, but frequently colourless; the alimentary canal green (when empty it is only visible as a weak brownish or reddish shade); the anal flap margined by a fine dark line on either side; the head transparent, pale brown, with darker brown sides, yellow-brown mouth-parts and darker sutures; the forehead suture anteriorly convex, thick, dark brown, as also are two divergent curved lines concave to one another, bounding the clypeus. Generally the younger larvæ are more deeply coloured, often amber-yellow with a greenish tinge, owing to the green intestinal canal. The anterior segments bear, ventrally, lozenge-shaped spots, which commence in a large brown subcutaneous throat-spot, and are more compressed on segments nearest head; these are very small and inconspicuous in young larvæ." Wood notes the larva as "mining with the venter uppermost," and it has the habit, Nolcken says, of retiring into the mined petiole to moult. The full-fed larvæ remain some time in the mine (they have been found in leaves covered with snow), and when they do spin their cocoons they do not change to pupæ until the spring.

Cocoon.—The cocoons examined (9) average almost 3 mm. in length, and 2·2 mm. in width. The cocoon is almost oval in outline, one end, however, being decidedly broader than its nadir, very distinctly domed both above and below the rim, the latter being composed of a mass of loose, flossy silk. The cocoon proper is closely woven, of a dark drab (inclining to greenish or brownish in different cocoons) colour, loosely invested in a thick covering of shining, flossy silk, which is somewhat paler than the inner part of the cocoon. The empty pupa-case, which projects from the broader end of the cocoon, is quite transparent and colourless, the abdominal segments being provided dorsally with a broad belt of shiny brown hooks. [Described from cocoons sent by Dr. Wood, July 12th, 1898.] The larva forms, on the ground, a flat, pale brown and rather woolly cocoon, from which the pupa protrudes just before the escape of the imago (Vaughan).

Food-plants.—*Populus tremula*. Also *P. alba* (Sorhagen).

Time of appearance.—The species is single-brooded, appearing in May and June, from larvæ that feed up the previous July-November, and do not pupate until a short time before the emergence of the imago. Vaughan reared imagines in March-April, 1859, from larvæ found the previous October and November, at Bristol. Stainton obtained imagines at Beckenham from May 20th-25th, 1851, and on June 9th, 1849, at Woodhead Moors, nr. Sheffield; whilst Threlfall caught imagines at Witherslack on May 14th, 1875; he also bred imagines from larvæ obtained the previous October, from May 12th-22nd. Mann records it at the beginning of June, 1846, at Pratovecchio; and Evans captured imagines at West Wemyss on May 30th, 1895. Nolcken records larvæ from September 20th, throughout October and into November, annually, at Pichtendahl, most easily found in the fallen leaves, the mined area remaining green.

Localities.—Durham: Darlington (Sang). Edinburgh: Ravelrig Bog (Logan). Fife: West Wemyss (Evans). Gloucester: Bristol (Vaughan). Hants: New Forest (Bankes). Hereford: Tarrington (Wood). Kent: Beckenham (Stainton). Lancashire: Grange (Hodgkinson). Sussex: Abbott's Wood (Fletcher). Westmorland: Witherslack (Threlfall). Yorks: Woodhead Moors (Stainton), Sheffield (Wilson), Scarborough (Meek).

Distribution.—Austria : nr. Vienna (Mann). Denmark : Lyngby, Brede, Rudehegn (Bang-Haas). France : Solope, St. Florent, Allogny (Sand), Marseilles (Himighoffen). Germany : generally distributed (Heinemann and Wocke), Potsdam, Havelland, Friedland, Stettin, Hamburg (Sorhagen), Alsace (Peyerimhoft), Dantzig (Tiedemann), Glogau (Zeller). Italy : Pratovecchio, Tuscany (Mann). Russia : Pichtendahl (Nolcken), Livland (Lienig). Scandinavia : Uleåborg (Tengström), south and middle Sweden (Wallengren). Switzerland : nr. Zürich (Frey).

NEPTICULA SUBAPICELLA, Stainton (? sp. præc.).

Synonymy.—Species : *Subapicella*, Sta., "Ent. Mo. Mag.," xxii., p. 238 (1886). *Argyropeza*, Sta., "Ins. Brit.," p. 300 (1854) ; "Nat. Hist. Tin.," i., p. 12 (1855) ; "Man.," ii., p. 433 (1859) ; "Nat. Hist. Tin.," vii., p. 188 (in part), pl. ix., fig. 2 (1862) ; Meyrick, "Handbook," etc., p. 726 (1895).

Original description.—In the *Ent. Mo. Mag.*, xxii., pp. 237-238, the name *N. subapicella* is suggested by Stainton for the imago described and figured in the *Nat. Hist. Tin.*, vol. vii., pp. 190-191, and pl. ix., fig 2, under the name of *N. argyropeza*, the life-history really belonging to the latter species. The description here referred to reads as follows : "This species belongs to that section of the genus in which the blackish anterior wings have two marginal pale spots ; in this section it can only be confused with *N. apicella*, but *N. argyropeza* (=*subapicella*) has the costal spot nearer the base of the wing than in that species ; in *N. apicella* the costal and dorsal spots are exactly opposite, in *N. argyropeza* (= *subapicella*) the costal spot is decidedly anterior to the dorsal spot. Expansion of the wings 3 lines. Head ferruginous. Antennæ dark fuscous, with the basal joint whitish. Anterior wings coarsely scaled, blackish, with a small dull whitish spot on the costa, rather before the middle, and a larger one on the inner margin a little beyond the middle ; cilia whitish. Posterior wings with their cilia grey." The oldest description of this species, however, is in the *Insecta Britannica*, p. 300, where Stainton writes : "Alis anticis nigrescentibus, macula parva costæ ante medium, macula dorsi post medium majore albidis ; capillis fulvis. Exp. al. 3 lin. Head and face deep luteous. Palpi whitish. Antennæ dark fuscous, basal joint whitish. Anterior wings blackish, with a small whitish spot on the costa, rather before the middle, and a larger one on the inner margin beyond the middle ; cilia whitish. Posterior wings grey, with paler cilia."

Time of appearance.—The imago has only been taken in May and June, on palings at Beckenham, by Stainton. The specimens in his collection are labelled respectively June 17th and June 22nd, 1851. The larva is unknown.

Locality.—Kent : Beckenham (Stainton).

NEPTICULA HEADLEYELLA, Stainton.

Synonymy.—Species : *Headleyella*, Sta., "Ins. Brit.," p. 300 (1854) ; "Nat. Hist. Tin.," i., p. 11 (1855) ; "Man.," ii., p. 432 (1859) ; H.-Sch., "Sys. Bearb.," v., p. 356 (1855) ; Frey, "Linn. Ent.," xi., p. 395 (1857) ; Staud. and Wocke, "Cat.," p. 339 (1871) ; Fletcher, "Ent. Mo. Mag.," xxiii., pp. 187-8 (1887) ; Meyr., "Handbook," etc., p. 726 (1895). *Argyrostigma*, Frey, "Die Tineen," etc., p. 379 (1856) [*teste*, Frey, "Lep. der Schweiz," p. 425 (1880)].

Original description.—*Nepticula headleyella*, n. sp. Alis anticis griseis, grosse squamatis, maculis duabus parvis argenteo-albidis, oppositis pone medium, costali anteriore; capillis luteo-griseis. Exp. al. 2 lin. Head and face luteous, mixed with grey. Palpi whitish. Antennæ grey, basal joint whitish. Anterior wings rather coarsely scaled, dark grey, with two small whitish-silvery opposite spots beyond the middle, that on the costa being nearer to the base; between these spots is a considerable breadth of the ground-colour; cilia grey. Posterior wings grey with paler cilia (Stainton, *Insecta Britannica*, p. 300).

IMAGO.—Head yellowish-grey. Anterior wings 4-6 mm., dark grey; two small whitish silvery opposite spots beyond the middle; cilia grey with whitish tips. Posterior wings grey, cilia paler.

EGG-LAYING.—The egg is laid on the upper surface of a leaf of *Prunella vulgaris* (Fletcher).

MINE.—The young larva makes a long and very narrow gallery in the blade of the leaf, often running halfway, or even all round the edge of it, the frass forming a continuous dark central line. After a while, the larva bores down the petiole of the leaf and up that of another, sometimes the opposite one, sometimes one of those at the next node. This leaf, usually buried among long herbage, becomes of a dull purple colour, while the larva is tunnelling up its foot-stalk, owing probably to the interference with its sap-supplies hastening its ripening. Arrived at the blade of this leaf, the larva makes a wide blotch-like mine, often moving a great part, or even the whole, of the parenchyma, unless the leaf be a very large one, when the mine takes the form of a broad zigzag gallery. Should the second leaf be very small, a third, or even a fourth, leaf may be mined. The frass forms a broad, broken, dark line in the middle of the mine (Fletcher).

LARVA.—The full-fed larva is about two lines long; head very pale brown; body bright yellow; food showing through in the dorsal region as a long, dark green blotch.

COCOON.—The cocoons examined (10) average about 2·1 mm. in length, and 1·6 mm. in width. They vary considerably in shape, some being almost circular in outline, others (spun up among moss) are spindle-shaped and considerably pointed towards each end. The normal shape appears to be somewhat pyriform, one end being much wider than its nadir; the broad end is somewhat flattened on its margin, the narrow end rising somewhat gradually to the upper convex surface of the cocoon. The colour is of a deep chocolate-brown, and the tint agrees marvellously with that of a dead *Prunella* leaf, on the upper surface of which the cocoon is apparently normally spun. The cocoon is enveloped in a moderately thick coating of loose flossy silk, of the same dark coloration as the central structure. [Described under a two-thirds lens, September 19th, 1898, from cocoons sent by Mr. W. H. B. Fletcher.] Fletcher writes: "The cocoon is dark brown, mussel-shaped, slightly keeled at the larger end, and rather flossy."

FOOD-PLANT.—*Prunella vulgaris*, preferring the radical leaves.

TIME OF APPEARANCE.—The insect is double-brooded, imagines appearing in May (end)-June and the end of August, from larvæ that feed up in September (end)-October and July-August (beginning) respectively. Tompkins records the imago on June 8th, 1855, at Headley Lane; Stainton, on June 23rd, 1856, in the same locality, also in the beginning of June, 1857, at Mickleham, whilst one specimen in Stainton's collection is noted as captured at Headley Lane, June 30th, 1857; Fletcher took imagines in June, 1885, followed by others in August of the same year; Douglas also found imagines in August, 1853, in Headley Lane. Mines were taken by Fletcher in October, 1885, in Arundel Park, and by Warren in the same month and year in Headley Lane.

LOCALITIES.—SURREY: Headley Lane (Douglas), Mickleham (Stainton). SUSSEX: Arundel Park, not uncommon (Fletcher). WILTSHIRE (Meyrick). The specimens recorded from "YORKSHIRE: Scarborough (Stainton)" must be referred to *N. eurema*.

NEPTICULA EUREMA, n. sp., Durrant.

SYNONYMY.—Species: *Eurema*, n. sp. *Cryptella*, Sta., "Ent. Weekly Intell.," iv., p. 102 (1858); "Man.," ii., p. 432 (in part) (1859); "Tin. of Southern Europe," pp. 229 and 359 (1869); Mill., "Cat. Lep. Alp. Mar.," p. 373 (1875); Porritt, "List of Yorks. Lep.," p. 171 (1886); Wlsm., "Ent. Mo. Mag.," xxvii., p. 152 (1891).

IMAGO.—Head and face ochreous. Antennæ fuscous externally, pale cinereous on their inner sides; eye-caps whitish. Palpi whitish. Thorax sooty. Forewings whitish, densely irrorated with sooty scales, slightly beyond the commencement of the apical third of the costa a fascia of the pale ground colour, variable in width and slanting slightly outwards, runs to the dorsum. (This fascia is sometimes divided into costal and dorsal spots by the dark scaling.) Cilia whitish, with a few sooty scales near the termen, and with a dividing line of sooty spots. The ♀ with the fascia broader and more distinct than in the male. Exp. al. ♂ 6 mm., ♀ 5 mm. (but both sexes often smaller). Hind-wings pale cinereous, cilia somewhat paler and more yellowish. Abdomen dark cinereous; anal tuft of ♂ whitish. Hind-legs whitish. Type: ♂ and ♀ Mus. Wlsm. (described from British specimens, Harper coll.). Hab. Scotland: Melvish (Sutherland). Larva: *Lotus corniculatus*, excl. ix., 1886, five specimens (Durrant, July 15th, 1898, *in litt.*).

VARIATION.—*N. eurema* is variable in size, but it is generally a smaller and more stumpy species than *N. cryptella*. British specimens would, as a rule, seem to be strongly fasciate in the ♀; in the ♂ the fascia is not so broad nor so distinct, and is sometimes (rarely) broken into opposite spots (Durrant). Bankes notes the "white-spotted or fasciated form," taken at Purbeck, as apparently larger than the "unicolorous insect from the Sussex downs." An extensive series, bred by Wilkinson at Scarborough, is exceedingly variable, some specimens having only the single spot on the inner margin, others having also a costal spot, whilst in some the two spots are united to form a rather broad fascia (Stainton). Porritt notes that Wilkinson mistook this "spotted" form for *N. headleyella*.

COMPARISON OF NEPTICULA EUREMA AND N. CRYPTELLA.—*N. cryptella* was described from specimens without pale spots, but fine specimens usually have a pale obscure triangular spot on the dorsum before the tornus. *N. cryptella* is, as a rule, a larger and more elongate species than *N. eurema*. It seems probable that Stainton had both species before him when writing the description in the *Manual*, ii., p. 432, for he remarked "sometimes with indications of pale opposite spots beyond the middle" (Durrant). Probably these were Wilkinson's specimens (*Intell.*, iv., p. 102). Durrant says that "at present he is not disposed to separate from *N. eurema* specimens bred from *Dorycnium hirsutum*, by Walsingham, at Hyères; in these, however, the spots are widely separated, and rarely tend to coalesce and form a fascia. It is probable that another species is indicated by these specimens, and the *N. cryptella*, bred by Stainton and Millière from *Dorycnium*, at Cannes and Mentone, are almost certainly the same as Walsingham's specimens from Le Tryas and Hyères."

COCOON.—Pale greenish on *Lotus*; brownish-ochreous on *Dorycnium* (Durrant).

FOOD-PLANTS.—*Lotus corniculatus*, *Dorycnium hirsutum*.

TIME OF APPEARANCE.—Double-brooded. Sang took larvæ on *Lotus*, on July 11th, 1858, at Castle Eden, June 28th, 1862, June 14th, 1872, September 7th, 1873, at Darlington, July 15th, 1873, September 26th, 1878, at Scarborough (*teste* Gardner). Hodgkinson also notes larvæ on *Lotus* in the last week of September, at Scarborough. Threlfall bred imagines June 28th-July 6th, 1879, from larvæ obtained at Durham, on *Lotus*, September 15th, 1878, and Walsingham bred others on September 21st, 1886, from larvæ on *Lotus*, obtained the previous month at Melvish, in Sutherland. Millière notes imagines as emerging, at Mentone, in March, and Stainton bred specimens on March 17th, 1867, from larvæ found at Cannes, on January 31st, on *Dorycnium*. Walsingham obtained imagines at Le Tryas. on April 14th, 1881, and bred others July 7th, August 10th, 14th, 21st, 1890, from larvæ found at Hyères in October and November, 1890, on *Dorycnium*.

LOCALITIES.—DORSET: Purbeck (Bankes). DURHAM: Castle Eden, Darlington (Sang). ? LANARK: Langside (King). ? LANCASHIRE (Hodgkinson). SUTHERLAND: Melvish (Walsingham). WESTMORLAND: Arnside (Threlfall). YORKSHIRE: Scarborough (Wilkinson).

DISTRIBUTION.—France: Cannes (Stainton), Mentone (Millière), Hyères, Le Tryas (Walsingham).

NEPTICULA CRYPTELLA, Stainton.

SYNONYMY.—Species: *Cryptella*, Sta., "Ent. Ann.," 1856, p. 41; "Man.," ii., p. 432 (1859); "Nat. Hist. Tin.," vii., p. 148 (1862); Frey, "Die Tineen," etc., p. 378 (1856); "Linn. Ent.," xi., p. 389 (1857); Staud. and Wocke, "Cat.," p. 340 (1871); Hein. and Wocke, "Schmett. Deutsch.," p. 769 (1877); Meyr., "Handbook," etc., p. 726 (1895).

ORIGINAL DESCRIPTION.—*Nepticula cryptella*, Frey, n. sp. Alis anticis angustulis albidis, saturate-griseo-squamatis; capillis ochreis, fusco-mixtis. Exp. al. 2½ lin. Head and face dark ochreous, mixed with fuscous; palpi whitish; antennæ fuscous, basal joint whitish. Anterior wings with coarse dark grey scales upon a whitish ground; cilia pale grey. Posterior wings pale grey, with paler cilia (Stainton, *Ent. Ann.*, 1856, p. 41).

[Although both Stainton and Frey published descriptions of this species in 1856, there can be no doubt that Stainton's was the earlier, for Frey (*Die Tineen*, etc., p. x) includes *The Ent. Ann.*, for 1856, in his list of the "Literatur," to which reference has been made. Frey's diagnosis refers undoubtedly to Stainton's species. It reads: Capillis rufis, antennarum conchula alba; alis anter. grosse squamatis, nigris, squamis multis albis intermixtis, ciliis dilutissime griseis, anguli analis saturatioribus; tarsis posticis unicoloribus, albidis. 3-2½''' (Frey, *Die Tineen*, etc., p. 378)].

Imago.—Head reddish-ochreous. Anterior wings 4-5 mm., pale greyish, irrorated with coarse dark scales; cilia very pale grey, darker at anal angle. Posterior wings and fringes dark grey.

Sexual dimorphism.—The fore-wings differ somewhat in shape according to the sex. In the male the wings are rather narrow, whilst those of the female are distinctly broader (Frey).

Comparison of N. cryptella with its allies.—It cannot be mistaken for any of the foregoing species. Only *N. pygmaeella* bears any resemblance to it in wing colour, and this similarity is only superficial, as the latter has much finer scales, and the head-tuft is paler yellow (Frey). *N. cryptella* is most nearly allied to *N. septembrella* and *N. pulverosella*. From the former it is distinguished by the longer and narrower anterior wings being of a paler colour, and more coarsely scaled, and by the absence of the conspicuous pale spot at the anal angle. From *N. pulverosella* it is distinguished by the much narrower anterior wings, and the darker colour of the head (Stainton). It is also closely allied to *N. euphorbiella* (Durrant).

Comparison of Nepticula eurema and N. cryptella.—Fletcher writes on the possibility of two species being included in cabinets under the name of *N. cryptella* as follows: "I obtain, here, on the downs, a form which is unicolorous, or at any rate 'spotless,' reminding one of a small *Trifurcula immundella*. I take it among *Lotus corniculatus*, and found it also (May 13th, 1893) in a bog among (I doubt not) *Lotus major*, but I have not been able to find the larva. I have seen several *N. cryptella* sent out by Sang. These are quite a different looking insect, with two pale opposite spots, which sometimes form a straight fascia. I have only four of the latter form, which I bought at the sale of the Revd. H. Burney's insects, and as they are 2 ♂ and 2 ♀, the difference is not sexual. My series of the unspotted form agrees with the description in the *Ent. Annual*, 1856, p. 41, where it is compared with *N. septembrella*, and the absence of a spot particularly noticed. I feel sure we have here two species, and it would appear that both are attached to *Lotus*" (*in litt.*, June 27th, 1898). Durrant writes: "In the 'Walsingham' (British) collection are specimens unicolorous, and with only a dorsal spot, and these appear to be a larger and more elongate species than the remaining specimens, which are generally fasciate, but very rarely with the fascia broken into opposite spots. The unicolorous species is the *N. cryptella* of Stainton, Frey and Wocke. A good name for the fasciate species would be *eurema* (the unexpected). I divide the specimens in the collection as follows: (1) *N. cryptella*, Sta.—About half Lord Walsingham's British specimens (Larva: *Lotus corniculatus*, *teste* Fletcher). (2) *N. eurema*, Drnt. MS.—(*a*) About half Lord Walsingham's British specimens (from Harper's coll., Lot 880, Stevens', May, 1884). (*b*) Fine specimens bred from Melvish, in Sutherland, by Lord Walsingham, from *Lotus corniculatus*. (*c*) Several specimens from Hyères and Le Tryas, bred from *Dorycnium hirsutum*, by Lord Walsingham. The specimens bred from *Dorycnium* are variable, some with a fascia, others with opposite spots" (*in litt.*, June 29th, 1898). Bankes notes: (1) 34 specimens from "low undercliff, just above level of beach, of the fasciated form, some might almost equally well be called opposite-spotted." (2) 7 specimens from a "damp meadow, all plain and unspotted." (3) 4 specimens from "dry downs, all plain and unspotted." All these were from Purbeck. He adds: "In both forms large and small examples occur."

MINE.—The mine is very curious in many ways, chiefly reminding one, however, of that of *N. septembrella*. The larva commences it as a very fine dark brown gallery, which twists a number of times in the small leaflets; this small gallery suddenly widens out into a large, pale, brownish spot, often filling the whole leaf, in which the fine, irregular windings of the gallery are partly or wholly lost. These mines are generally found in shady grassy places in woods, rarely in open meadows (Frey).

LARVA.—The larva is pale yellow-green in colour, the head light brownish, its length over 2‴ (Frey).

FOOD-PLANTS.—*Lotus corniculatus*, ? *Lotus major*.

TIME OF APPEARANCE.—The species is, according to Frey, double-brooded, imagines appearing in May, June and August, from larvæ feeding respectively in September, October and July. The experience in Britain suggests only a single brood, the imagines in May-June being produced from larvæ that feed up in July-August. Thus Stainton bred an imago May 16th, 1857, from a larva obtained at Headley Lane, July 19th or 21st, 1856. Douglas captured imagines by sweeping the herbage at Headley Lane, at the end of June, 1855, and on June 23rd, 1856; whilst on June 10th, 1857, Stainton also obtained imagines in the same locality. Fletcher found specimens on May 13th, 1893, near Worthing.

LOCALITIES.—DORSET: Portland, Weymouth (Richardson), Purbeck (Bankes). HEREFORD: Woolhope (Wood). LANARK: (? *N. eurema*) Langside (King). LANCASHIRE: (? *N. eurema*) Manchester (Stainton), Grange, Preston (Hodgkinson). NORFOLK: nr. K. Lynn (Atmore). SURREY: Headley Lane (Douglas), Mickleham (Stainton). SUSSEX: Arundel Park, High Down, Worthing (Fletcher).

DISTRIBUTION.—Austria: Vienna (Heinemann and Wocke). Germany (Wocke). Switzerland: Zürich (Frey).

NEPTICULA PULVEROSELLA, Stainton.

SYNONYMY.—Species: *Pulverosella*, Sta., "Cat.," p. 30 (1849); "Ins. Brit.," p. 307 (1854); "Man.," ii., p. 438 (1859); H.-Sch., "Sys. Bearb.," v., p. 339 (1855); Staud. and Wocke, "Cat.," p. 340 (1871); Nolck., "Lep. Fn. Estl.," p. 797 (1871); Hein. and Wocke, "Schmett. Deutsch.," p. 769 (1877); Frey, "Lep. der Schweiz," p. 426 (1880); Meyr., "Handbook," etc., p. 726 (1895).

ORIGINAL DESCRIPTION.—*Trifurcula pulverosella*, n. sp. Not properly belonging to this genus (*Trifurcula*); but very like the preceding (*T. immundella*), only darker, and head ferruginous. Scarce. I have taken it among grass in May (Stainton, *Sys. Cat. Brit. Tin. and Pterophoridae*, p. 30). The species was later diagnosed (*Insecta Britannica*, p. 307) by Stainton, as follows: "Alis anticis albis, grosse cinereo-squamatis, capillis ferrugineis. Exp. al. 3 lin. Head and face ferruginous. Palpi whitish. Antennæ grey, basal joint whitish. Anterior wings with coarse dark ashy-grey scales, upon a paler ground; cilia yellowish-white. Posterior wings pale grey, with yellowish-white cilia. A few specimens have occurred in May and June among wild apple bushes."

IMAGO.—Head reddish. Anterior wings 6-7 mm.; pale greyish-ochreous, irrorated with coarse dark scales; cilia grey, outer half of apical cilia paler. Posterior wings light grey; cilia pale yellowish.

NOTE OF COMPARISON BETWEEN N. PULVEROSELLA AND N. CRYPTELLA.—

N. pulverosella is allied to *N. cryptella*, but is larger, and the cilia of the anterior wings are paler (Frey).

EGG-LAYING.—The egg is laid on the underside of a leaf (Nolcken).

MINE.—The mine is formed on the upperside of a leaf. It begins as a fine gallery, which is filled with frass, and in its earliest part is very irregular, except when it follows the margin of a leaf. The second part forms an oval blotch, the middle of which is filled with frass, the latter being attached to the upper surface of the leaf; the frass forms a large irregular spot, the particles of frass not being so thick at the sides as in the centre. The first part of the mine is often absorbed in the blotch, and the latter forms a large rust-red spot, the central area being rusty-brown, the edges more washed-out and yellowish-brown in tint. The exit is made from the lower side in the examples before me (Nolcken). The larva makes large blotch-mines in apple-leaves (Stainton).

LARVA.—The larva is wax-yellow in colour, more intensely tinted towards the anus. The head is brown, with dark mouth-parts and sutures. The intestinal canal, which can be seen on the venter, as a somewhat broad, brownish, pale-edged longitudinal stripe, is on the upper side pale and indistinctly visible.

COCOON.—The cocoons form a long oval in outline with a narrow flat rim, and are red rust-brown in colour.

FOOD-PLANT.—*Pyrus malus*, preferring wild bushes.

TIME OF APPEARANCE.—The species is single-brooded, the imagines appearing in May-June, from larvæ that feed up the previous July. Bower captured imagines May 14th, 1897, by beating apple at Eltham. Stainton collected mines between June 20th-30th, 1851, the imagines from which commenced to appear May 15th, 1852. He also bred many others between April 4th-12th, 1852, from larvæ found at Lewisham, on wild apple. Nolcken found mines on July 16th, 1892, at Rotsiküll, that produced imagines the middle of May of the following year. Sang found mines at Darlington, on July 18th, 1874, July 14th, 1877. Frey bred (probably in the house) imagines in March, 1858, at Zürich, from larvæ received from Stainton the previous July. Bankes bred imagines from March 14th-23rd, 1893, from larvæ received from Epping Forest in July, 1892, the cocoons having been kept in a warm room with a fire. The moths emerge from about 8.30-10.30 a.m.

LOCALITIES.—DORSET: Purbeck (Bankes). DURHAM: Darlington (Sang). ESSEX: Epping Forest (Bankes). GLOUCESTER: Bristol (Stainton). KENT: Lewisham (Stainton), Eltham (Bower). LANCASHIRE: Dutton (Hodgkinson), Grange (Threlfall). SURREY: Haslemere (Barrett). SUSSEX: generally distributed (Fletcher). YORKSHIRE: Scarborough, common (Wilkinson).

DISTRIBUTION.—Germany (Heinemann and Wocke). Russia: Rotsiküll (Nolcken). Switzerland: nr. Zürich (Frey).

GROUP VII.—Cilia of the anterior wings with a distinct or indicated divisional line, beyond which they are abruptly paler. Anterior wings coarsely scaled, with only a whitish dorsal spot.

NEPTICULA SEPTEMBRELLA, Stainton.

SYNONYMY.—Species: *Septembrella*, Sta., "Cat.," p. 29 (1849); "Ins. Brit.," p. 299 (1854); "Nat. Hist. Tin.," i., p. 168, pl. iv., fig. 2 (1855); "Man.," ii., p. 432 (1859); H.-Sch., "Sys. Bearb.," v., p. 356 (1855); Frey, "Die Tineen," etc., p. 377 (1856); "Linn. Ent.," xi., p. 391 (1857); Const., "Cat. Lep. Saone-et-

Loire," p. 354 (1866); Staud. and Wocke, "Cat.," p 339 (1871); Nolck., "Lep. Fn. Est.," p. 790 (1871); Hein. and Wocke, "Schmett. Deutsch.," p. 763 (1877); Sand, "Cat. Lep. Auv.," p. 202 (1879); Peyer., "Cat. Lep. Als.," 2nd Ed., ii., p. 167 (1882); Sorhagen, "Die Kleinschmett. Brandbg.," p. 309 (1886); Meyr., "Handbook," etc., p. 724 (1895).

ORIGINAL DESCRIPTION.—*Nepticula septembrella*, n. sp. Anterior wings blackish, with a single yellowish spot on the disk near the anal angle; head ferruginous; antennæ greyish. One specimen taken by Mr. Bedell, at West Wickham, last September (Stainton, *Sys. Cat. of Brit. Tin. and Pterophoridae*, p. 29). Following this, Stainton wrote (*Insecta Britannica*, p. 299) an extended diagnosis as follows: "Alis anticis nigris, macula triangulari dorsi pone medium albida, capillis ferrugineis; antennis fuscis; tarsis posticis unicoloribus albidis. Exp. al. 2 lin. Head and face reddish-yellow. Palpi whitish. Antennæ fuscous, basal joint whitish. Hinder tarsi unicolorous whitish. Anterior wings black, with a rather triangular whitish spot on the inner margin beyond the middle; cilia whitish. Posterior wings whitish-grey, with paler cilia."

IMAGO.—Head reddish-yellow. Anterior wings 4 mm.; black; a somewhat triangular whitish spot on inner margin towards anal angle; cilia whitish. Posterior wings whitish-grey, cilia paler.

COMPARISON OF N. SEPTEMBRELLA WITH ITS ALLIES. — This species belongs to that section of the genus in which the dark-coloured anterior wings have a single pale spot on the inner margin, placed not towards the middle, as in *N. intimella*, but towards the anal angle, nearly as in *N. catharticella*. From this last species, which it very closely resembles, it may be distinguished by the tarsi being unicolorous whitish, and not annulated with dark fuscous. The pale spot of the anterior wings is also a little larger and less shining (Stainton).

EGG-LAYING.—The egg is deposited on the underside of a leaf of *Hypericum*.

MINE.—The mine commences as a long and extremely slender gallery, in which the excrement appears at first as a reddish-brown line, but, as it proceeds, the excrement becomes darker, till it appears nearly black; after going round and across the leaf two or three times, a blotch is formed, and the excrement is then deposited in little arcs of circles, very similarly to that of *Cemiostoma scitella* and *C. laburnella*. Finally the mined blotch occupies the entire leaf, if it be a small one, and the narrow lines of the original gallery still being distinctly visible, give it a singular appearance (Stainton). Wood notes that "the mine consists, in its first portion, of a gallery, and ends in a distinct blotch; the latter is not commenced until some little time after the larva has passed its third moult." Threlfall notes it as "most intricate and blotch-like."

LARVA.—Length 2 lines; shining, transparent, light yellow; the dorsal vessel showing through greenish; head small, brown, much concealed beneath the prothorax; the latter dark brown anteriorly; the meso- and metathorax the largest; those beyond taper gradually to the posterior end (Stainton). Wood notes that "the larva, which makes a hollow or balloon-like blotch, partakes much of the *Micropteryx* type, being without legs, and with deep segmental incisions;" also that "the dark ventral spots found in the middle life of some Nepticulid larvæ, remind one of some of the ventral spots in some of the Micropterygids (*i.e.*, Eriocraniids). The larva mines with the venter uppermost."

Cocoon.—The full-fed larva puckers the leaf in which it has been mining, and, in the cavity thus formed, it constructs its pale ochreous, elliptical, flat-edged cocoon, the wider end of which is attached to the lower cuticle of the leaf, so that when the pupa protrudes its anterior segments, it likewise pushes through the skin of the leaf, and the perfect insect makes its appearance on the same side of the leaf as that upon which the egg was laid (Stainton).

Food-plants.—*Hypericum pulchrum*, *H. perforatum*, *H. hirsutum* (Corbett), *H. quadrangulum* (Healy), *H. tomentosum* (Frey .

Time of appearance.—The insect is double-brooded, the imagines appearing in May-June and August from larvæ that feed from September-March and July-August respectively. We captured imagines on June 23rd, 1888, at Chattenden. Miller bred imagines August 3rd-5th, 1856 ; Stainton, on January 29th, March 10th, November 28th, 1852, January 5th, March 9th, 1853, March 27th-31st, April 6th, May 5th, 1854, all from West Wickham, and on May 31st, 1850, from Wanstead. From mines obtained July 24th, 1876, at Windermere, Threlfall bred imagines on August 16th of the same year. Atmore bred imagines from May 15th-22nd, 1898, out-of-doors, from larvæ collected the previous autumn at King's Lynn. Threlfall records larvæ at Witherslack, July 21st and during October, 1876 ; Healy, larvæ on October 7th, 1858, at Highgate Wood, October 14th, at Bishop's Wood (when nearly every leaf of three plants contained larvæ). Douglas notes that on October 19th, 1856, in Darenth Wood, every leaf of the plants found was tenanted with a larva, the larvæ being in all stages of growth, from just hatched to full grown. Stainton obtained pupæ in the budding leaves in February and March, 1857, in West Wickham Wood. Sand notes that the October-November larvæ produce imagines in May, at Nohaut, whilst Peyerimhoff observes that October larvæ produce April imagines in Alsace. Nolcken notes that at Strandheuschlage, every leaf of some plants contained mines on September 9th, 1865, others being quite free.

Localities.—Cheshire : Bowdon (Edleston). Dorset : common in woods in county (Richardson), Bloxworth (Cambridge), Purbeck (Bankes), Glanvilles Wootton (Dale). Dublin : Howth (Birchall). Durham : Darlington (Sang). Essex : Wanstead (Stainton). Gloucester : Bristol (Stainton). Hants : New Forest (Bankes). Hereford : Tarrington (Wood), Leominster (Hutchinson). Kent : Darenth (Douglas), West Wickham (Bedell), Chattenden (Tutt), Lewisham, Beckenham (Stainton). Lancashire : Manchester (Stainton), Grange, Silverdale (Threlfall). Leicester : Market Harboro' (Matthews). Middlesex : Bishop's Wood, Hampstead, Highgate Wood (Healy). Norfolk : Merton (Barrett), King's Lynn (Atmore). Sussex : widely distributed in E. and W. Sussex, High Down, etc. (Fletcher), Guestling (Bloomfield), Lewes (Stainton). Westmorland : Arnside, Windermere, Witherslack (Threlfall). York : Scarborough (Wilkinson), Doncaster, very abundant (Corbett), Edlington Wood (Warren), Richmond (Sang).

Distribution.—France : Saone-et-Loire (Constant), Nohaut, Indre (Sand). Germany : generally distributed (Heinemann and Wocke), Finkenkrug, Potsdam, Stettin, Halle, Hamburg (Sorhagen), Alsace (Peyerimhoff), Ratisbon (Herrich - Schäffer), Frankfort - on - Main (Heyden), Giessen (Frey). Russia : Pichtendahl, Strandheuschlage (Nolcken). Switzerland : Bremgarten (Boll), nr. Zürich, on the Mürtschenalp, at 5,000ft. (Frey).

NEPTICULA CATHARTICELLA, Stainton.

Synonymy.—Species: *Catharticella*, Sta., "Zool.," 1853, p. 3955 and p. 3958; "Ins. Brit.," p. 299 (1854); "Nat. Hist. Tin.," i., p. 178, pl. iv., fig. 2 (1855); "Man.," ii., p. 432 (1859); H.-Sch., "Sys. Bearb.," v., p. 356 (1855); Frey, "Die Tineen," etc., p. 377 (1856); "Linn. Ent.," xi., p. 390 (1857); Sta., "Tin. of Southern Europe," pp. 228-229 (1869); Staud. and Wocke, "Cat.," p. 339 (1871); Nolck., "Lep. Fn. Est.," p. 790 (1871); Mill., "Cat. Lep. Alp. Mar.," p. 373 (1875); Hein. and Wocke, "Schmett. Deutsch.," p. 763 (1877); Sand, "Cat. Lep. Auv.," p. 202 (1879); Wallgrn., "Ent. Tids.," ii., pp. 130-131 (1881); Snellen, "De Vlinders," p. 1006 (1882); Peyer., "Cat. Lep. Als.," 2nd Ed., ii., p. 167 (1882); Sorhgn., "Die Kleinschmett. Brandbg.," pp. 309 and 356 (1886); Hering, "Stett. Ent. Zeit.," lii., p. 221 (1891); Const., "Bull. Soc. His. Nat. Autun," v., p. 82 (1892); Meyr., "Handbook," etc., p. 724 (1895).

Original description.—In the *Zoologist*, xi., p. 3955, Stainton writes: "About the middle of last October, I paid a visit one morning to a bush of *Rhamnus catharticus*, on which I expected to find the autumnal brood of the larvæ of *N. catharticella*," etc. Again, on p. 3958, he writes: "To the species on buckthorn, closely allied to *N. septembrella*, and not hitherto described, I have given the name of *N. catharticella*." Stainton afterwards diagnosed (*Insecta Britannica*, p. 299) the species as follows: "Alis anticis nigris, dilutissime purpureo-tinctis, puncto minuto dorsi pone medium albo; capillis ferrugineis; tarsis posticis albidis, fusco-annulatis. Exp. al. 2½ lin. Head and face reddish-yellow. Palpi whitish. Antennæ fuscous, basal joint whitish. Hinder tarsi whitish, annulated with dark fuscous. Anterior wings black, with a very faint purple tinge, with a minute white spot on the inner margin near the anal angle; cilia whitish. Posterior wings pale grey, with pale grey cilia."

Imago.—Head reddish. Anterior wings 5-6 mm.; black with a faint purple tinge; a minute white spot on inner margin near the anal angle; cilia with pale grey bases, outer half white. Posterior wings and cilia pale grey.

Comparison of N. catharticella with its allies.—*N. cartharticella* belongs to that section of the genus in which the dark-coloured anterior wings have a single pale spot on the inner margin; the position of the spot at the anal angle, and not merely a little beyond the middle, distinguishes it from *N. intimella*, beside the antennæ being yellowish in that species and fuscous in *N. cartharticella*. From *N. septembrella* it is less easy to separate it, but the pale spot is smaller, and rather more posteriorly placed, and the hind tarsi are annulated with dark fuscous, whereas in *N. septembrella* they are unicolorous whitish (Stainton).

Egg-laying.—The egg is laid on the underside of a leaf of *Rhamnus catharticus*, generally close to the midrib.

Mine.—The mine is at first very narrow, slightly twisted, and filled with green or greenish-grey excrement, so nearly the colour of the leaf that it is not easily perceptible. At the end of the mine the larva appears distinctly green, and is much more easily seen than when in its long track. As the mine gradually becomes broader it is generally more contorted and the excrement darker (ultimately nearly black), and placed in regular arcs, but still occupying the whole width of the mine. About half-an-inch from the point by which the larva quits the leaf, the excrement becomes more scanty, and occupies only the centre of the mine, leaving a whitish-green margin on either side (Stainton). Frey notes it as "composed of very narrow windings, not unlike those of *N. viscerella*. The frass is collected into a broad stripe, and only towards the end is it deposited in a line, so that a greenish margin borders the gallery." A mine made in *Rhamnus alaternus* (larva noticed below) is described as "a broad gallery, almost a narrow blotch; the old part of the mine brownish, the recent part pale green; the excrement dark brown, at first nearly occupies the whole width of the mine, afterwards blacker, and only occupies the central portion of it."

Larva.—Length 2 lines; pale greenish-amber; head pale brown, and two pale brown lobes, showing through the prothorax; mouth and two slender lines receding from it reddish-brown (Stainton). Larvæ obtained by Stainton, at Mentone, on *Rhamnus alaternus*, were described as follows: "Length 2 lines, pale amber, dorsal vessel greener; head pale brown, with the mouth and sutures darker, and with a short dark mark posteriorly" (*Tin. of Southern Europe*, pp. 228-229). The larva mines with its dorsum uppermost (Wood).

Cocoon.—The cocoon is very pale ochreous, rather flossy and elongate, almost pointed at the narrow, and rounded at the broader end. From the latter, the anterior segments are protruded before the emergence of the imago (Stainton). Sorhagen says "pale yellow and pear-shaped."

Food-plants.—*Rhamnus catharticus* and *R. alaternus*.

Time of appearance.—Double-brooded, the imagines appearing in May-June (March, in confinement), and July-August, from larvæ found in October and June-July respectively. Stainton obtained mines at Lewisham on October 26th, 1851, and again in July and October, 1852. From the latter, he bred imagines almost continuously from February 1st-June 24th, 1853. He also bred the summer imagines from July 9th-26th, 1863. Sorhagen notes the larvæ at Hamburg as occurring "singly" in July, "commonly" in October, in hedges and on outskirts of woods. Threlfall obtained imagines August 5th-15th, 1878, from larvæ collected July 16th, at Witherslack; and Durrant bred imagines on June 15th, 1898, from larvæ collected at Merton the preceding October. Bower notes mines on October 5th, 1891, at Darenth, October 27th, 1897, at Lee. From mines obtained March 14th, 1867, on *R. alaternus*, near Pont St. Louis, Mentone, imagines emerged April 30th-May 10th, 1867. De Peye also notes mines in March on the same plant at Cannes.

Localities.—Cambridge: Cambridge, Wicken, Cherryhinton (Farren), Cambridge (Warren). Dorset: Bloxworth (Cambridge), Glanvilles Wootton (Dale), Weymouth (Richardson). Gloucester: Bristol (Vaughan). Hereford: Tarrington (Wood). Kent: Lewisham (Stainton), Alkham (Beale), Lee, Darenth (Bower). Lancashire: Grange, Silverdale (Threlfall). Norfolk: King's Lynn, Swaffham, Croxton (Atmore), Merton (Durrant). Surrey: Sanderstead (Bower). Sussex: Arundel Park, Salvington Down, nr. Worthing, common (Fletcher), ? Guestling (Bloomfield). Westmorland: Witherslack (Threlfall). York: (Stainton), Scarborough (Wilkinson).

Distribution.—France: Cannes (Millière), Alpes Maritimes (Constant), Nohaut (Sand), Pont St. Louis, nr. Mentone, (Stainton). Germany: generally distributed (Heinemann and Wocke), Alsace (Peyerimhoff), Frankfort-on-the-Main (Schmid), Potsdam, Berlin, Finkenkruge, Hamburg, Hanover, Breslau (Sorhagen), Alt Damm, nr. Stettin, Misdroy (Hering). Netherlands: North Brabant (Snellen). Russia: Pichtendahl (Nolcken). Scandinavia: Scania (Wallengren). Switzerland: Zürich (Frey).

NEPTICULA INTIMELLA, Zeller.

Synonymy.—Species: *Intimella*, Zell., "Linn. Ent.," iii., p. 323 (1848); Sta., "Ins. Brit.," p. 299 (1854); "Man.," ii., p. 432 (1859); H.-Sch., "Sys. Bearb.," v., p. 356 (1855); Frey, "Linn. Ent.," xi., p. 393 (1857); Nolck., "Lep. Fn. Est.," p. 792 (1871); Staud. and Wocke, "Cat.," p. 339 (1871); Hein. and Wocke, "Schmett. Deutsch.," p. 764 (1877); Sorhagen, "Ent. Nach.," xi., p. 280 (1885); "Die Kleinschmett. Brandbg.," p. 309 (1886); Meyr., "Handbook," p. 724 (1895).

Original description.—*Nepticula intimella*, n. sp. Alis anterioribus violaceo-fuscis, macula dorsi medii argentea, ciliis externe canis; capillis ferrugineis; antennis cum conchula exalbidis. Ein einzelnes Weibchen, in der Grösse einer kleinen *N. argyropeza* und dem Weibchen derselben sehr gleichend. Grundfarbe der Vorderflügel dunkel violettbraun, auf den Franzen an der Spitze mit dem dunkeln Schuppenringe eingefasst. Die specifischen Unterschiede scheinen folgende zu sein: Der Vorderrandfleck fehlt auf den Vorderflügeln wie jeder andere Fleck; nur der Innenrandfleck ist vorhanden fast dreieckig, auf dem Rande ruhend an der gewöhnlichen Stelle, aber silberweissglänzend. Gegen den dichten, lebhaft rostgelben Haarschopf auf dem Kopfe stechen die grossen, gelblichweissen, glänzenden Augendeckel sehr ab. Während bei *N. argyropeza* ♀ nur das Wurzelglied der Fühler gelblichweiss ist, sind hier die ganzen Fühler ganz einfarbig blassgelb. An den Beinen sehe ich keine Verschiedenheit. Dieses einzelne Exemplar fing ich bei Glogau; doch weiss ich nichts Näheres darüber (Zeller, *Linnaea Entomologica*, iii., p. 323).

Imago.—Head reddish-ochreous. Fore-wings 5-6 mm.; blackish-fuscous; a shiny yellowish spot on the inner margin just beyond the middle of the wing; cilia fuscous. Posterior wings and cilia grey.

Comparison of Nepticula intimella with its allies.—The yellowish eye-caps and the slightly yellowish hind tarsi distinguish *N. intimella* from *N. septembrella* and *N. catharticella*. The scaling of the wings also is finer than in *N. septembrella*, and the fringes are considerably darker than in *N. catharticella*. Finally the spot is placed much nearer to the base of the wing, before the centre of the costa, and is distinctly yellowish, which Herrich-Schäffer, incorrectly, denies (Frey).

Egg-laying.—The egg is laid on the stalk of *Salix russelliana*, or on the upper surface of the midrib of *S. caprea* (Wood).

Mine.—The young larva burrows into the stalk or midrib of its food-plant, and, in the latter part of its life extends its mine into the blade; forming a small blotch projecting from the side of the midrib. Wood observes that the presence of a larva in the leaves of *Salix russelliana* is shown by one lateral half of the leaf being yellow or brown, whilst the other remains green. Sorhagen describes the mine as "mixed," running at first in the midrib, then expanding laterally into a brown blotch, which widens gradually. In the blotch-part of the mine the frass lies towards the outside, in two parallel lines, between which the larva rests when not eating. When disturbed it retires into that part of the mine situated in the rib.

Larva.—The larva is pale yellowish in colour, transparent, posteriorly attenuated, with vivid green intestinal canal from segments 4-10. Head small, light brownish in colour (Sorhagen).

Cocoon.—The cocoons (4) examined average 2·8 mm. in length and 2·1 mm. in width. They are oval (almost oblong-oval) in shape, with a distinct lateral rim projecting all round the edge. The colour of the cocoons is of a dull brown, the rim much paler. From the inner edge of the rim the cocoon is regularly arched to the central point, and somewhat plentifully covered with flossy silk, of a paler brown colour than the body of the cocoon, although the cocoons look quite smooth to the naked eye. The rim is also plentifully supplied with loose flossy silk. [Described July 13th, 1898, under a two-thirds lens, from cocoons sent by Dr. Wood.]

FOOD-PLANTS.—*Salix russelliana* and *S. caprea* (Wood), *S. fragilis* (Heinemann and Wocke). [Cambridge records (*Ent.*, xxvi., p. 89) the species from "birch" an evident error.]

TIME OF APPEARANCE.—The species is single-brooded, appearing in June, from larvæ that feed up in August-November. Hodgkinson records sweeping imagines from sallow, at Witherslack, June 9th, 1870. Threlfall bred specimens June 20th, 1880, from larvæ obtained the preceding September and October, at Windermere. In Stainton's collection are specimens captured on Dartford Heath, June 23rd, 1852, and others bred by Threlfall, at Preston, May 18th, 1888. Cansdale obtained larvæ in October, 1876, at Witham, that produced imagines the following June. Wocke notes the imago as appearing at the end of June, in Silesia, from October-November larvæ, and Nolcken records mines on September 24th, 1864, at Pichtendahl.

LOCALITIES.—BERKS: Reading (Hamm). DERBY: Burton (Sang). DORSET: Purbeck (Bankes), Bloxworth (Cambridge). ESSEX: Witham (Cansdale). GLOUCESTER: Bristol (Sircom). HEREFORD: Tarrington (Wood). KENT: Dartford Heath (Stainton). LANCASHIRE: Grange, Preston (Hodgkinson). SOMERSET: Brislington (Sircom). SURREY: Haslemere (Barrett). SUSSEX: Abbott's Wood, rare (Fletcher). WESTMORLAND: Windermere (Threlfall), Witherslack (Hodgkinson).

DISTRIBUTION. — Germany: Glogau (Zeller), Frankfort-on-Main (Heyden), Friedland, nr. Hamburg (Sorhagen), Silesia (Wocke), Breslau (Durrant). Russia: nr. Pichtendahl (Nolcken), Porgas nr. Åbo (Reuter). Switzerland: nr. Zürich (Frey).

GROUP VIII.—Cilia of the anterior wings with a distinct or indicated divisional line, beyond which they are abruptly paler. The anterior wings coarsely scaled, usually with a whitish costal spot, or a whitish fascia, and with one or more other whitish spots.

NEPTICULA QUINQUELLA, Bedell.

SYNONYMY.—Species: *Quinquella*, Bedell, "Zool.," 1848, p. 1986 (with figure); Sta., "Ins. Brit.," p. 301 (1854); "Man.," ii., p. 433 (1859); Frey, "Linn. Ent.," xi., p. 407 (1857); Staud. and Wocke, "Cat.," p. 339 (1871); Meyr., "Ent. Mo. Mag.," xiv., p. 111 (1877); "Handbook," etc., p. 725 (1895); Warren, "Ent. Mo. Mag.," xx., p. 188 (1884).

ORIGINAL DESCRIPTION.—*Microsetia quinquella.* Expansion of wings 2-2½ lines; anterior wings deep black, with the base and three spots silvery-white; one placed towards the posterior angle of the inner margin; another on the costa near the base, and a third, somewhat central, near the apex; cilia silvery; posterior wings and cilia dusky, head black. It bears some resemblance to *M. subbimaculella.* I found this beautiful and very distinct species in considerable plenty on the trunks of oaks in the heath-field at West Wickham, on the 30th of June last (1847) (Bedell, *Zoologist*, vi., p. 1986).

IMAGO.—Head dark fuscous. Anterior wings 5-6 mm.; dark bronzy-fuscous; transverse silvery spot on costa before middle of wing; a triangular silvery spot on inner margin beyond the middle;

a small round silvery-white spot between latter and apex; cilia silvery-grey. Posterior wings dark grey with paler cilia.

Mine.—The larva mines the leaves of oak, preferring low bushes to trees. The mine is very narrow, and excessively contorted, as though rolled into a ball, thus occupying a very confined space (Meyrick).

Larva.—The greenish larva of *N. quinquella* may be distinguished from the other oak-feeding larvæ with great ease, by the character of the dorsal vessel; this is very distinct, forming a row of conspicuous dark spots down the back, which are easily perceptible through the leaf, when held up to light (Meyrick).

Time of appearance.—The species appears to be single-brooded, the imagines appearing from May-July, from larvæ that feed up in October-November. Imagines were taken on oak-trunks, at West Wickham, June 30th, 1847 (Bedell); in profusion, on Bishop's Fence, Addington, June 28th, 1859 (Stainton), whilst in Stainton's collection are specimens labelled as taken June 9th, 1848, on palings, at Beckenham, and on July 7th, 1852, at West Wickham, on oak-trunks. Commence to emerge in the middle of June, and continue to do so throughout July at Cambridge (Meyrick). Meyrick found larvæ, mostly young, on November 6th, 1876, at Cambridge (when the mines of the other three oak-feeding species were almost all empty). A week later they were in extraordinary profusion, the oakbushes (that stand pretty thickly in their locality) having every leaf holding literally from twenty to thirty larvæ. Many held from 50 to 100, and in one large leaf Meyrick counted 123. The effect upon the appearance of the bushes was very conspicuous, barely a vestige of green remaining, although, at that season, a casual observer would doubtless have set it down as the result of natural decay. Warren says that from 1877-79 the mines were equally abundant in the neighbourhood of Cambridge, after which the species seemed to disappear, only particular trees produced them, and then only in small numbers. Later they became abundant again. Farren found them in the greatest profusion in 1892, "the larvæ being full-fed at the beginning of October. In one plantation, about a mile from Cambridge, every oak-leaf seemed to have many mines. One leaf contained 72. The imagines emerged in May, 1893, and, on a bright day, the trunks of the oak trees were crowded with the moths. There were literally millions."

Localities.—Cambridge: Cambridge (Meyrick), Madingley, nr. Cambridge (Warren). Essex: Wickham Bishops (Cansdale). Kent: West Wickham (Bedell), Beckenham (Stainton). Suffolk: Flixton (Cruttwell). Surrey: Addington (Stainton).

NEPTICULA SERICOPEZA, Zeller.

Synonymy.—Species: *Sericopeza*, Zell., "Isis," 1839, p. 215; "Linn. Ent.," iii., p. 325, fig. 48 (1848); Sta., "Ins. Brit.," p. 301 (1854); "Man.," ii., p. 433 (1859); "Ent. Ann.," 1864, p. 170; H.-Sch., "Sys. Bearb.," figs. 841-2 (1853); v., p. 358 (1855); Frey, "Linn. Ent.," xi., p. 402 (1857); Const., "Cat. Lep. Saone-et-Loire," p. 354 (1866); Frey, "Stett. Ent. Zeit.," 1871, p. 125; Wocke, "Ibid.," pp. 428-430; Nolcken, "Lep. Fn. Est.," p. 792 (1871); Staud. and Wocke, "Cat.," p. 339 (1871); Hein. and Wocke, "Schmett. Deutsch.," p. 764 (1877); Sand, "Cat. Lep. Auv.," p. 202 (1879); Warren, "Ent. Mo. Mag.," xviii., pp. 142-143 (1881); Wallgrn., "Ent. Tids.," ii., p. 130 (1881); Curò, "Bull. Soc. Ent. Ital.," xv., p. 109 (1883); Warren, "Ent. Mo. Mag.," xx., pp. 186-187 (1884); Sorhagen, "Die Kleinschmett. Brandbg.," p. 310 (1886); Meyrick, "Handbook," etc., p 725 (1895). ? *Louisella*, Sircom (*teste* Stainton). *Acerella*, Sta., "Ent. Annual," 1864, p. 171.

? *Decentella*, H.-Sch., "Sys. Bearb.," v., p. 358 (1855) [= ? 2nd gen., *teste*, Frey. "Lep. der Sch.," p. 425 (1880)].

ORIGINAL DESCRIPTION.—*Sericopeza*, Z. Grösse der *Opost. spartifoliella*, also grösser als die 4 vorigen Arten (*N. hemargyrella*, *argyropeza*, *argentipedella*, *lemniscella*): die Vorderflügel zugerundet. etwas glänzend, grob schwarzbeschuppt mit violetter Spitze; eine Binde vor und 2 Gegenflecke hinter der Mitte gelblichweiss; die Kopfhaare schwarz oder rostgelb; die Augendeckel gelblich. Viele Exemplare im Thiergarten bei Berlin an Baumstämmen im Mai gefangen (Zeller, *Isis*, 1839, p. 215). Zeller afterwards diagnosed (*Linn. Ent.*, iii., p. 325) the species as follows: "Alis anterioribus fuscis, basi, fascia curva media maculisque duabus oppositis posticis pallidis; capillis ferrugineis, conchula albida, antennis fuscescentibus."

IMAGO.—Head reddish-orange. Anterior wings 6-8 mm.; blackish; an oblique whitish fascia before the middle; two opposite yellowish-white spots beyond the middle; cilia very pale yellowish-grey. Posterior wings pale grey, with paler cilia.

VARIATION.—Frey considers that *N. decentella*, H.-Sch., may be a small summer generation of this species. Herrich-Schäffer's diagnosis reads as follows:—"*N. decentella*, m. *Suppl.*, 815. (*Sericopeza*, Sta., eher hieher.) Capillis nigerrimis, thorace omnino flavido." Herrich-Schäffer then gives a detailed description in German, and notes the species as coming from Frankfort-on-the-Main (Mühlig) and England, in June.

EGG-LAYING.—The eggs are laid on the keys. Warren watched a female ovipositing in the middle of September, 1881, on the keys that were then green.

MINE.—The mine usually commences near the middle of the wing of a fruit, and passes towards the stalk, winding much before the cavity containing the fruit is reached. It is most conspicuous between the two fruit wings. When the larva has reached the space containing the seed, it lives here for a time without mining, and a large heap of excrement is collected therein. The terminal part of the mine forms a comparatively large empty space, where the larva emerges from the key (Wocke). Goureau notes that the larva feeds in the seeds of *Acer platanoides*, and causes the samaras or keys to fall before the seeds are perfectly ripe, owing to the flow of sap being checked. The affected portion of the keys becomes blackish.

LARVA.—When full-grown, 4 mm. long; pale amber-yellow in colour, transparent and slightly glossy; the alimentary canal slightly green; the head of the same pale yellow tint as the body, with two very fine brown lines converging to the front and with very fine brown dusting, the mouth brown; the posterior part of the body slightly darker (Wocke).

COCOON.—When fresh the cocoon is very bright yellow and very neatly spun, but when discoloured it becomes dirty-white or pinkish. In April, the hybernated larvæ spin their cocoons on the tree-trunks (Wocke). On June 13th, 1859, Goureau detected a nearly circular cocoon on a fallen key of *Acer platanoides*, and from other keys (that had fallen before the seeds were perfectly ripe) collected, four or five larvæ emerged, and spun flat white or whitish-rosy cocoons on the keys. In May, 1883, Warren found freshly-spun cocoons, both on the new, half-developed keys, and on the fresh young leaves of *Acer campestris*, near Cambridge; they were all at, or near, the extremity of the lower boughs of a tree which grew on a hedgebank, the lower branches of the tree spreading far across a considerable ditch, and then over the pathway alongside of it. At the end ot August, 1881, Warren found a number of cocoons on the keys (often unmined) and leaves of maple, also some on the leaves of an elder bush growing beneath the maple. The cocoons found on the leaves were on the upper surface, and, when on the keys, generally at the extreme tip. Warren considered there must have been some hundreds of cocoons on the one tree from which these were gathered, as he collected about six score within reach of his stick. In no instance did he find the cocoon attached to the mined key, as described by Stainton. It is unknown how, or where, the winter larvæ hybernate, but Warren says there can be no doubt that the April and May larvæ have hybernated and not fed up quickly in the early spring.

Time of appearance. — The species is double- or probably continuously-brooded, the imagines appearing in April-May from hybernated larvæ, again in June-July from larvæ that feed up in May-June, and yet again August (end)-September from larvæ feeding up in August (early). Mann records imagines at the beginning of May, 1846, at Salviano, in Tuscany, on maples. He also obtained others in May, at Brussa, in Asia Minor. Goureau bred imagines June 28th-July 1st, 1859, from larvæ obtained June 13th, 1859, at Santigny. Stainton took imagines, on the Dartford Heath fence, on June 22nd, 1852, and again on June 28th, 1863, at Lewisham. Warren bred imagines in June from cocoons spun by hybernated larvæ the last week of May, 1883, and the same observer had previously bred imagines throughout September, 1881, from cocoons collected at the end of August at Cambridge. In the second week of September, 1881, Warren discovered a female busy ovipositing, and hence surmised that there might be a succession of broods all the summer. Threlfall has specimens bred August 20th from larvæ obtained August 7th, at Cambridge. Sorhagen gives the imago as appearing in April (end)-May, and again in June (end)-July, at Hamburg, the former from hybernated larvæ, the latter from larvæ that mine in the fruits of *Acer campestris* at the end of May. Nolcken found imagines May 25th-28th, 1850, at Riga, on the linen material of a tent in his garden, placed under some old trees of *Acer campestris*. Wocke discovered full-fed larvæ in April, hanging from the twigs by silken threads or spinning cocoons on trunks of trees. These produced imagines in about fourteen days, imagines of the next brood appearing from the commencement to the end of June, the pupal life of this brood being shorter than that of the former brood. He adds that the larvæ of the summer brood can be found when the ripe and unripe maple keys are falling in numbers. Frey records imagines at Zürich in May, 1867, and later in the year cocoons on the same tree-trunks. The first generation mined the fruit which the larvæ leave near the stalk at the end of May. The larvæ of the second brood hybernate from autumn to end of April, when they pupate (Sorhagen).

Food-plants.—*Acer platanoides* (Goureau), *Acer campestre* (Wocke), *Acer pseudo-platanus* (Frey).

Localities.—Cambridge: nr. Cambridge (Warren). ? Gloucester: Bristol (Sircom). Kent: Dartford Heath, Lewisham (Stainton). Sussex: Arundel Park (Fletcher).

Distribution.—Asia Minor: Brussa (Mann). Austria: Vienna (Mann). France: Santigny (Goureau), Saone-et-Loire (Constant), Nohaut, Indre (Sand). Germany: generally distributed (Heinemann and Wocke), Berlin (Zeller), Frankfort-on-Main (Wocke), Potsdam, Eberswalde, Hamburg, etc. (Sorhagen). Italy: Tuscany (Mann), Piedmont (Curò), Dogliani, Sardinia (Ghiliani). Russia: Riga (Nolcken). Scandinavia: Upland (Wallengren) Akarshus, 59°55' N. lat. (Reuter). Switzerland: nr. Zürich (Frey).

NEPTICULA WEAVERI, Stainton.

Synonymy.—Species: *Weaveri*, Sta., "Ent. Ann.," 1855, p. 49, pl. i., fig. 5; "Nat. Hist. Tin.," i., p. 10 (1855), vii., p. 182, pl. ix., fig. 1 (1862); "Man.," ii., pp. 432-3 (1859); H.-Sch., "Sys. Bearb.," v., p. 356 (1855); Frey, "Die Tineen," etc., p. 377 (1856); "Linn. Ent.," xi., p. 390 (1857); Hein., "Wien. Ent. Monats.," vi., p. 319 (1862); Hein. and Sta., "Zool.," xxi., p. 8384 (1863); Nolck., "Lep. Fn. Est.," p. 791 (1871); Staud. and Wocke, "Cat.," p. 339 (1871); Hein. and Wocke, "Schmett. Deutsch.," p. 764 (1877); Sand, "Cat. Lep. Auv.," p. 202 (1879); Wallgrn., "Ent. Tids.," ii., p. 131 (1881); Snellen, "De Vlinders," etc., p. 1005 (1882); Sorhgn., "Die Kleinschmett. Brandbg.," p. 347 (1886); Meyrick, "Handbook," etc., p. 725 (1895). *Weaverella*, Dbldy., "List," p. 36 (1866); Porritt, "List. Yorks. Lep.," p. 171 (1886).

Original description.—*Nepticula weaveri*, Douglas, n. sp. (*see* frontispiece, fig. 5). Alis anticis saturate purpureo-nigris, fascia obliqua abbreviata ante medium, macula parva anali luteo-albis. Exp. al. 3½ lin. Head and face ferruginous. Antennæ fuscous, the basal joint yellowish. Anterior wings dark purplish-black; on the costa, before the middle, is an oblique broad pale yellowish spot reaching to the fold; on the inner margin, at the anal angle, is a smaller yellowish-white spot; cilia whitish. Posterior wings grey, with pale grey cilia. The larva was found by Weaver, in Perthshire, last May (1854), mining in the leaves of *Vaccinium vitis-idaea*, and puckering them, having a similar habit to *N. septembrella*, and forming its cocoon within the leaf. . . . . It is a large, conspicuous species, and may be readily known by the abbreviated, broad, oblique whitish fascia from the costa before the middle, and the small whitish spot at the angle of the dark purplish anterior wings [Stainton, *Ent. Annual*, 1855, p. 49 (1st Ed.), pp. 71-72 (2nd Ed.)].

Imago.—Head ferruginous. Anterior wings 6-8 mm.; coarsely scaled; blackish; a conspicuous oblique silvery-white spot on the costa before the middle; a roundish spot of a similar colour at the anal angle; cilia pale grey. Posterior wings grey with paler cilia.

Egg-laying.—The egg is laid on the underside of a leaf, generally towards the centre, but not necessarily near a rib. It forms a long oval in outline, and those on the old mines examined are full of black frass.

Mine.—The mine commences as a slender gallery, which, as in that of *N. septembrella*, is carried backwards and forwards two or three times across the leaf before it expands into a blotch, the excrement forming a central blackish line; eventually the larva eats out much of the internal substance of the leaf, which then puckers, and assumes an inflated appearance. Nolcken notes that "as soon as the brown swollen blotch is completed the leaf falls off, the life of the leaf being no longer necessary to the larva. The frass is collected into a large heap at the end of the brown blotch."

Larva.—Length 2½ lines. Pale amber, the dorsal vessel slightly darker; head pale brown, with two pale brown lobes showing through the skin of the second segment (Stainton). Threlfall notes the larva as "green."

Cocoon.—The cocoon is spun inside a bladdery cavity between the upper and under epidermis of a leaf. These cavities measure about 11 mm. by 9 mm. The cavity is lined with fine, flossy, whitish silk, and the cocoon proper is loosely suspended in the centre by silken fibres. The cocoon itself forms a long oval, about 4 mm. long, and 2 mm. wide, the two ends also being almost equal. It varies in colour from a bright orange to a pale sulphur-yellow, the latter form reminding one much of the cocoon of *Clisiocampa neustria*, both in texture and tint. The surface has a very fine flossy exterior, made, however, of such short silken fibres that it looks comparatively smooth, except for the suspending silken web. [Described September 10th, 1898, under a two-thirds lens, from cocoons sent by Mr. W. H. B. Fletcher, obtained at Rannoch.] Stainton notes the cocoon as "long and pale ochreous;" Nolcken observes that the suspensory web is double, and the cocoon placed between. He also adds that "this silk lining, and not the eating out of the leaf-substance, is evidently the cause of the swelling of the blotch." Heinemann notes that the imago makes its escape "through a slight silken tube, which leads from the cocoon to the skin of the leaf."

Food-plant.—*Vaccinium vitis-idaea*. Gregson observes that the leaf containing a full-fed larva often falls to the ground.

Time of appearance.—Possibly double-brooded, since Threlfall has obtained imagines in April from larvæ collected in August, and others July 15th-20th, 1879, from larvæ collected May 3rd of the same year, at Stalybridge. Sand also notes October larvæ on Mont Dore, but states that the imagines did not appear till the following June. Heinemann notes that in the Upper Hartz larvæ and pupæ may be found until the middle of June, whilst in the lower country they occur in May. Edleston obtained larvæ in May, 1857, that produced imagines June 21st-August 24th, 1857. Batty sent us larvæ in May, 1888, from nr. Sheffield, that produced imagines June 24th-30th. In the Stainton collection are imagines captured July 18th and 27th, 1864, at Huddersfield. Weaver found larvæ in May, 1854, at Rannoch. Gregson records larvæ on April 16th, 1856, at the Brushes, nr. Manchester, and at Chorley on April 21st, 1856. Zeller found larvæ at Meseritz on April 7th, 1861; and Bower notes them on May 16th, 1889, June 26th, 1891, June 8th, 1892, at Sheffield, and May 18th, 1891. Nolcken records larvæ about the middle of May, at Pichtendahl.

Localities.—Aberdeen: Braemar, rare (Reid). Cheshire: Bowdon (Edleston). Hereford: Black Mountains (Wood). Lancashire: the Brushes, nr. Manchester, Chorley (Gregson), Dutton (Hodgkinson), Stalybridge (Chappell). Pembroke: (Meyrick). Perthshire: Rannoch (Weaver). Yorkshire: Sheffield (Batty), Scarborough, common (Wilkinson), Huddersfield (Stainton).

Distribution.—France: Gravenoire, Mont Dore (Sand). Germany: Upper Harz, Brunswick, Hanover (Heinemann), Glogau, Meseritz (Zeller), Breslau, Dresden (Stainton); distributed in N. Germany, Stettin, etc. (Sorhagen). Netherlands: Gelderland (Snellen). Russia: Pichtendahl (Nolcken), Finland (Wocke), Russian Carelia (Reuter). Scandinavia: Scania and Småland (Wallengren).

Group IX.—Cilia of the anterior wings with a distinct or indicated divisional line, beyond which they are abruptly paler. Anterior wings coarsely scaled; with whitish markings in the basal half.

NEPTICULA TRIMACULELLA, Haworth.

Synonymy.—Species: *Trimaculella*, Haw., "Lep. Brit.," p. 583 (1828); Sta., "Cat. Tin.," p. 29 (1849); "Ins. Brit.," p. 301 (1854); "Nat. Hist. Tin.," i., p. 216, pl. vi., fig. 1 (1855); "Man.," ii., p. 433 (1859); Frey, "Die Tineen," etc., p. 381 (1856); "Linn. Ent.," xi., p. 404 (1857); Staud. and Wocke, "Cat.," p. 339 (1871); Nolck., "Lep. Fn. Est.," p. 792 (1871); Hein. and Wocke, "Schmett. Deutsch.," p. 766 (1877); Sand, "Cat. Lep. Auv.," p. 202 (1879); Bang-Haas, "N. H. Tids.," p. 218 (1881); Peyer., "Cat. Lep. Als.," ii., 2nd Ed., p. 167 (1882); Snellen, "De Vlinders," etc., p. 1004 (1882); Sorhagen, "Die Kleinschmett. Brandbg.," p. 310 (1886); Meyr., "Handbook," etc., p. 725 (1895). *Rufella*, Zell., "Isis," 1839; "Linn. Ent.," iii., 328 (1848); Sta. and Zell., "Trans. Ent. Soc. Lond.," v., 137 (1848); H.-Sch., "Sys. Bear.," v., p. 358 (1855) (*nec.* Scopoli). ? *Populella*, H.-Sch., "Sys. Bear.," v., p. 357 (1855).

Original description. — *Tinea trimaculella* (The cream-spotted Sable). Alis atris stria lata basi, maculisque duabus posticis flavicantibus. Expansio alarum $2\frac{3}{4}$ lin. Præcedentibus (*T. sequella*) minor. Alæ anticæ atræ, striâ latissimâ emarginatâ, a basi fere ad medium lutescente; maculisque duabus posticis oppositis marginalibus fere confluentibus flavescentibus. Habitat forte in Populo. Imago i. Jul. Populi Truncis, at rarissime. Exemplarium unicum quod cepi sedentem solum vidi (Haworth, *Lepidoptera Britannica*, p. 583).

Imago.—Head ochreous. Anterior wings 5-6 mm.; dark fuscous; a broad, whitish, basal, longitudinal streak extending to centre of wing; two triangular, opposite yellowish-white spots (sometimes united) beyond the middle; cilia pale yellowish-grey. Posterior wings pale grey with paler cilia.

Sexual dimorphism.—The abdomen of the male is reddish-orange in colour, of the female grey. The legs of the male tinged with orange, of the female whitish-grey (Stainton).

Variation.—The species varies considerably in the size of the yellowish-white spots. One of these is referred to by Frey, under the name of *populella*. Nolcken notes the imagines from Pyha as having less sharply defined markings than examples received from Germany.

a. ab. *populella*, Frey.—The basal spot very large, extending almost across the wing from one margin to the other, and being united with the dorsal marginal spot.

Comparison of N. trimaculella with its allies.—*N. trimaculella* is the only species in which the dark anterior wings have two opposite pale spots and a broad basal streak. *N. subbimaculella* has the basal mark on the inner margin, forming a rather triangular spot there, whereas in *N. trimaculella* the basal mark is not connected with the inner margin, and, though broad, is best described as a basal streak (Stainton). This species is, in the male, owing to its red abdomen, and yellowish legs and hind-wings, quite safe from confusion with its allies, as *N. subnitidella*, the only species with similar hind-wings, has fore-wings without any markings. The female also cannot be confused, since *N. argyropeza*, *N. sericopeza* and *N. decentella* have entirely different markings. From *N. subbimaculella*, *N. trimaculella* differs in having a paler, more yellowish head, by the brown-black (not pure black) fore-wings, by the much larger basal streak (in *N. subbimaculella* this is placed on the dorsal margin), and by the opposite spots being larger and broader, and placed directly above and below each other (Frey).

Egg-laying. — The egg is laid on the upperside of a poplar or aspen leaf (Stainton). Nolcken, however, notes it as being laid on either the upper- or underside, usually singly, but frequently several on a leaf.

Mine.—The larva makes a long, narrow gallery for some distance close to one of the ribs; it then diverges and makes a broader mine, sometimes having the appearance of a blotch. The first third of the mine is completely filled with dark grey excrement; but as the mine is made wider the excrement is placed irregularly along the middle (Stainton). Frey notes it as "running in irregular curves, and with a pale green colour in the broadened part." Nolcken adds that "the frass in the first part of the mine appears to be deposited in a fluid state, resembling much a very narrow, oft interrupted thread, the frass becoming more solid and granular towards the end of the mine. The frass-line is bounded by pale, but not conspicuous, margins, which are of the same green colour as the leaf. The mine is only very occasionally twisted sufficiently to assume a blotch-like form." The mines are not always on the same side of the leaf, and Nolcken notes that four eggs laid on the underside of one leaf produced one "upperside" and three "underside" mines.

Larva.—Length 2 lines; very pale yellowish-green, with greener dorsal vessel; the head pale brown, the two posterior lobes showing through the upper surface of the second segment; the mouth and two lines receding from it reddish-brown (Stainton). The larva mines with the dorsum uppermost (Wood).

Cocoon.—The cocoons (4) examined average 2·8 mm. in length, and 2 mm. in width. They are somewhat irregular in shape, of an oblong-oval outline, thinned off somewhat at the rim, and not much domed above, the material tending to collapse irregularly after the emergence of the imago. The cocoon varies from bright orange-brown to red-brown in colour, and is somewhat plentifully covered with loose, flossy, silken fibres, some of which is quite white in colour. The empty pupa-case projects from what is the slightly broader end. The dorsum is transparent and colourless, but the venter is of a somewhat dark greenish-grey tint. [Described July 13th, 1898, under a two-thirds lens, from cocoons sent by Dr. Wood.] Stainton describes the cocoon as "oval, rather flat, and brown in colour," Frey adds that it is "smooth."

Food-plants.—*Populus tremula* (Wing), *P. pyramidalis* and *P. nigra* (Frey), *P. canadensis* (Heyden).

Time of appearance.—The species is double-brooded, the imagines appearing in May and August, from larvæ feeding in October and July respectively. Sang has obtained mines on June 23rd, 1874, October 19th, 1863, Octobor 17th, 1873, at Darlington. Bower notes mines as common on October 7th, 1891, at Lee, and October 21st, 1897, at Eltham, but Nolcken gives larvæ as occurring on August 18th, 1868, at Pyha, from which he bred imagines the following spring. Threlfall bred imagines in April, 1878, from larvæ obtained at Leyland, October 14th, 1877. Stainton notes imagines as bred on April 4th, 1855, May 3rd, 5th, 7th and 10th, 1864, June 16th, 1872, and August 3rd, 4th and 26th, 1855, at Lewisham.

Localities.—Cambridge: Cambridge (Farren). Cheshire: Bowdon (Edleston). Derby: Burton (Sang). Dorset: Purbeck (Bankes), Weymouth (Richardson). Durham: Darlington (Sang). Gloucester: Bristol (Stainton). Hereford: Tarrington (Wood). Kent: Lewisham (Stainton), Lee, Eltham (Bower). Lancashire: Manchester (Stainton). Leyland (Threlfall). Suffolk: Brandon (Warren). Surrey: Sanderstead (Elisha). Sussex: Bersted, Bognor, Worthing, common (Fletcher). Yorkshire: York (Stainton), Balby, nr. Doncaster (Warren), Scarborough (Wilkinson), Doncaster (Corbett).

Distribution.—Austria: Vienna (Metzner). Denmark: Copenhagen (Bang-Haas). France: Nohaut (Sand). Germany: generally distributed (Heinemann and Wocke), Potsdam, Hamburg, Hanover, Breslau (Sorhagen), Bohemia (F.-von-Röslerstamm), Frankfort-on-Main (Heyden), Glogau (Zeller), Alsace (Peyerimhoff), Reichstadt (Stainton). Netherlands: not rare, and generally distributed (Snellen). Russia: Riga, Pyha (Nolcken). Switzerland: nr. Zürich (Frey).

NEPTICULA ASSIMILELLA, Zeller.

Synonymy.—Species: *Assimilella*, Zell., "Linn. Ent.," iii., p. 327 (1848); Sta., "Nat. Hist. Tin.," i, p. 12 (1855); H.-Sch., "Sys. Bearb.," fig. 840 (1854), v., p. 355 (1855); Frey, "Die Tineen," etc., p. 380 (1856); "Linn. Ent.," xi., p. 406 (1857); Nolck., "Lep. Fn. Estl.," p. 794 (1871); Staud. and Wocke, "Cat.," p. 339 (1871); Hein. and Wocke, "Schmett. Deutsch.," p. 767 (1877); Bang-Haas, "N. H. Tids.," p. 218 (1881); Snellen, "De Vlinders," etc., p. 1003 (1882); Peyer., "Cat. Lep. Als.," ii., 2nd Ed., p. 167 (1882); Fletcher, "Ent. Mo. Mag.," xxii., p 113 (1885); Sorhagen, "Die Kleinschmett. Brandbg.," p. 312 (1886); Meyr., "Handbook," etc., p. 725 (1895). *Nigricornella*, Mann (*teste* Frey).

Original description.—*Assimilella*, Mtzn., n. sp. Alis anterioribus fuscis, basi, macula disci prope eam maculisque duabus posticis oppositis exalbidis; capillis ferrugineis; conchula albida; antennis fucescentibus (specim. 2, mus. Mtzn.). *Lyon. nigricornella*, Mann *in litt.* Nur in der Grösse des Weibchens der *N. argyropeza*; von diesem unterschieden durch die weiter nach hinten gerückten gelblichweissen Flecke der Vorderflügel und durch das Vorhandensein eines grossen hellen Fleckes im Mittelraum nahe der Basis. *Sericopeza* ist bedeutend grosser und hat statt dieses Fleckes eine Binde. *Rufella* ♀ hat die ganze Basis in einem sehr grossen Fleck gelblich. Rückenschild braun mit hellgelben Hinterrändern der Schulterdecken. Kopf wie bei der vorigen (*N. cursoriella*), aber die Augendeckel nur so gross, wie bei *N. argyropeza*; die Fühler glänzend bräunlichgrau, gelblich schimmernd (also ist der Name *nigricornella* mit Recht verändert worden). Beine gelblichgrau, glänzend. Hinterleib grau mit weisslichem Bauche. Vorderflügel $1\frac{1}{4}'''$ lang, schwarzbraun, grobschuppig, hinten erweitert; auf den hellgrauen Franzen rundet sich die dunkle Grundfarbe der Flügelfläche zwar hinten ab, jedoch nicht in einer verdunkelten Linie. Basis gelblich. Nicht weit davon liegt im Mittelraume ein ziemlich grosser, gelblicher, schlecht begrenzter Fleck, der vom Vorderrande fast so weit entfernt bleibt, wie von Innenrande; einzelne gelbliche Schüppchen scheinen ihn mit der Basis verbinden zu wollen. Hinter der Mitte liegt ein gelblichweisses, einwärts zugespitztes Vorderrandfleckchen, dem ein grösseres, mehr auswärts liegendes, seine Spitze zugewendet. Franzen weissgrau. Hinterflügel hellgrau auf beiden Seiten. Die Unterseite der Vorderflügel braungrau; die Franzen am hellsten an der Flügelspitze und am Innenwinkel. Ein schön erhaltenes Weibchen und ein Exemplar, dem die Hinterflügel und der Hinterleib fehlen, so dass ich in ihm nur ein Weibchen vermuthen kann, erhielt ich von Herrn Metzner zur Beschreibung;

beide sind von Wien [Zeller, *Linnaea Entomologica*, vol. iii. (1848), pp. 327-328].

Imago.—Head ferruginous. Anterior wings 4-5 mm.; fuscous in colour, the base whitish; a whitish spot on the disc, and two opposite whitish spots towards outer margin; cilia very pale grey, with whitish tips. Posterior wings and cilia grey.

Comparison of N. assimilella with its allies.—Although this species exhibits some variation in the size and distinctness of the whitish spots, it is not difficult to distinguish the different forms from the allied species, only two of which, *N. trimaculella* and *N. subbimaculella*, are likely to be confused with it. From the former the male may be separated by the dark colour of the body, legs and hindwings. Besides this, the head-hairs in *N. assimilella* are red, in *N. trimaculella* ochreous-yellow, the eyecaps purer white, and the epaulettes of the blackish dorsal-plate bordered with white, whilst the latter, in *N. trimaculella*, remain pale. In *N. trimaculella*, also, the longitudinal basal streak extends to the base of the wing, whilst in *N. assimilella* the spot is much smaller, rounder, and separated from the base by a portion of the black wing. In *N. assimilella* the opposite spots are placed somewhat obliquely, and the fringes lack the yellowish tinge which occurs in *N. trimaculella* (Frey).

Egg-laying.—Judging by my series, the egg is laid generally on the upperside of the leaf, close to the midrib, more rarely to one of the lateral ribs (Fletcher). Always laid on the upperside (Nolcken).

Mine.—The mine is irregular, but often strongly twisted, fine at its commencement, and filled with a dark frass-line; then it becomes considerably broader, at the termination, being often 2‴ in breadth; the frass in this last portion forming a somewhat fine and broken thread. Nolcken has recorded as many as 15 mines in one leaf, and says that the mine is characterised by the chalky-white, closely-twisted spot at the commencement of the mine. The latter widens rapidly, and becomes blotch-like, the windings lying close to one another, and without any partitions of the leaf-substance between. It is at first greenish-coloured, but then becomes more or less brownish-yellow. In no other species has such an inconspicuous frass-line been noticed, nor one of such small bulk. The frass-line commences as an exceedingly fine broken thread, with comparatively broad pale margins, which gradually increase still more. In the second portion it becomes more granular, but remains broken, and consists of little heaps, that approximately indicate the path of the larva, and which, in the strongly marked windings of the now broad mine, is somewhat difficult to trace. Frequently the frass lies about irregularly, and without arrangement, but always sparingly. The exit is always on the upper surface of the leaf.

Larva.—The larva is yellow in colour; head pale brown; the cephalic ganglia brown, rather darker than head; ventral chain invisible; abdominal canal green in front, yellow behind. Mines with the dorsum uppermost (Wood). Frey says that the larva is very similar to that of *N. trimaculella*. Nolcken describes the larva as lighter or darker wax-yellow, with reddish yellow-brown intestinal canal showing through the skin, the head brown.

Cocoon.—The cocoons (4) examined vary in shape and colour, one is dark brown, the others purplish-black; the dark brown one forms a long oval, the others a round oval, two of which measure 2·75 mm. in length and 2·2 mm. in width, whilst the third is 2·1 mm. long and 1·75 mm. wide. The cocoons are lightly covered with loose flossy silk, which is especially abundant about the ill-defined rim. The upper part is regularly domed, but reaches to no great height, the apex of the raised portion being towards the wider end. The empty pupa-case protrudes from the broader end, is transparent and colourless, with the exception of some irregular grey patches (? scales) on the venter of the thoracic area. [Described July 13th, 1898, under a two-thirds lens, from cocoons sent by Dr. Wood.] The cocoon is oval, reddish-brown in colour, somewhat flattened and shiny (Frey). Nolcken states that from about 50 cocoons, varying in colour between brownish-yellow and brown, he bred only one imago, probably because they were kept too wet.

Food-plant.—*Populus tremula.*

Time of appearance.—The species is probably single brooded. Fletcher, who added this species to the British list, found mines in September, 1884, from which he bred imagines in June, 1885. Frey found imagines in July and commencement of August, and larvæ in September and early October. Nolcken found larvæ at Pichtendahl from August 10th until the end of the month.

Localities.—Hereford: Tarrington (Wood). Sussex: Abbott's Wood (Fletcher).

Distribution.—Austria: nr. Vienna (Metzner). Denmark: Brede (Bang-Haas). Germany: generally distributed (Heinemann and Wocke), Alsace, Saverne (Peyerimhoff), Ratisbon (Herrich-Schäffer). Netherlands: Wassenaar, Gravenhage (Snellen). Russia: Pichtendahl (Nolcken). Switzerland: nr. Zürich (Frey).

NEPTICULA SUBBIMACULELLA, Haworth.

Synonymy.—Species: *Subbimaculella*, Haw., "Lep. Brit.," p. 583 (1828): Stphs., "Illus.," iv., p. 267 (1834); Wood, "Index," etc., fig. 1355, p. 196 (1839); Sta., "Cat. Tin.," p 29 (1849); "Ins. Brit.," p. 300 (1854); "Nat. Hist. Tin.," i., p. 258, pl. vii., fig. 3 (1855); "Man.," ii., p. 433 (1859); Frey, "Die Tineen," etc., p. 379 (1856); "Linn. Ent.," xi., p. 397 (1857); Staud. and Wocke, "Cat.," p. 339 (1871); Mill., "Cat. Lep. Alp. Mar.," p. 373 (1875); Hein. and Wocke, "Schmett. Deutsch.," p. 767 (1877); Sand, "Cat. Lep. Auv.," p. 202 (1879); Wallgrn., "Ent. Tids.," ii., p. 131 (1881); Peyer., "Cat. Lep. Als.," 2nd Ed., ii., p. 167 (1882); Snellen, "De Vlinders," etc., p. 1002 (1882); Curò, "Bull. Soc. Ent. Ital.," xv., p. 109 (1883); Sorhagen, "Die Kleinschmett. Brandbg.," p. 310 (1886). *Cursoriella*, Zell., "Linn. Ent.," iii., p. 326 (1848); Sta. and Zell., "Trans. Ent. Soc. Lond.," v., p. 135 (1848); H.-Sch., "Sys. Bearb.," fig. 844 (1853), p. 356 (1855); Mann, "Wien. Ent. Monats.," 1857, pp. 173 *et seq.*

Original description.—*Tinea subbimaculella* (The twin-spot Sable). Alis atris maculis duabus marginalibus argenteis. Expansio alarum 2½ lin. Caput fulvum. Alæ anticæ atræ, ipsa basi lente albicante; maculis duabus oblique oppositis fere confluentibus, argenteis; unâ medio marginis tenuioris, alterâ magis anticâ costali. Posticæ nigro-plumbeæ. Habitat: Imago Septis (Haworth, *Lep. Britannica*, p. 583).

Imago.—Head orange-yellow. Anterior wings 6 mm.; black; whitish patch at the base, extending along the inner margin; triangular whitish spot in middle of costa, a larger spot beyond this on inner margin; cilia whitish. Posterior wings pale grey, with paler cilia.

Egg.—The egg is laid on the upperside of an oak leaf, close to the midrib, or by the side of a large lateral rib. Its longest diameter is about ·28 mm., its width ·24 mm., and height ·1 mm. The surface is smooth and polished (Chapman).

Mine.—The larva commences to mine a very slender gallery, keeping close to the rib. In this mine the excrement forms a thick blackish central line; after a while, however, the larva mines in a blotch, forming an oblong about half an inch long and a quarter of an inch broad; in this the excrement is rather loosely and irregularly placed. When the larva is full-fed it creeps out through the upper cuticle of the leaf, and proceeds in search of a convenient place in which to form its cocoon (Stainton). Wood says that it is almost impossible to overlook the green, roughly triangular patches in the brown oak-leaves lying on the ground from September to November, in which are the mines of this species. The patches usually extend from an angle of the midrib for some little distance into the adjacent interspace, whilst at or near the apex is the larval blotch. The mine starts from the midrib (or a lateral one) and proceeds as a fine gallery, that keeps to the side of a rib. The peculiar influence exerted by the larva in the preservation of that part of a leaf in which a mine is placed is active during the making of the preliminary gallery; and Wood records that on August 15th, 1893 (at the hottest period of a most extraordinary summer), many brown and dead oak-leaves were picked up, quite shrunken and dry, except for the little patches containing the mines of this species, which were not only green but juicy.

Larva.—Length 2 lines; pale green in colour, shining, dorsal vessel reddish; head reddish, the mouth and two lines receding from it darker, the prothorax with two dark brown linear scales dorsally, and with a quadrangular dark patch ventrally. It is a singular fact in vegetable physiology, that when leaves are turning brown, the spots tenanted by these larvæ remain green much longer than the remainder of the leaf, and this may frequently be observed in the leaves after they have fallen (Stainton).

Cocoon.—The cocoons average about 2·5 mm. long and 1·75 mm. wide. Roughly oval in outline, with one end much wider than the other; a flattened rim round the broader end, the central and narrow end rising into a flattened dome. Colour brownish, somewhat yellower on the flattened rim. The cocoon moderately smooth, but with a fair supply of flossy silk round the projecting edge, by which it is fastened to either side of a leaf. [Described under a two-thirds lens, September 9th, 1898, from cocoons sent by Mr. W. H. B. Fletcher.] Stainton notes the cocoon as "pale whitish-ochreous in colour, rather flat, mussel-shaped, and only slightly flossy; the pupa protrudes its anterior segments from the broader end before the emergence of the imago."

Food-plants.—*Quercus robur* and *Q. pedunculata*.

Time of appearance.—This species appears to be only single-brooded, the imagines appearing in May and June, from larvæ that feed up in October-November. Millière, however, records imagines as being on the wing during December-January, at Cannes. It was taken by Mann, in May, 1853, at Fiume, and Reuter captured it in the I. of Aland, on May 13th, 1886. Bower captured imagines resting on *Rhamnus* leaves, on June 1st, 1894, at Chislehurst; we have found it throughout June, during many years at Chattenden, on the oak trunks, and Atmore notes it as one of the latest Nepticulid species to appear at King's Lynn. Stainton captured specimens May 29th, 1848, at Lewisham, on June 9th, 1848, at Beckenham, on June 15th, 1848, *in cop.*, at Penge, from June 20th-24th, 1849, at Lewisham, May 28th, 1850, June 17th-22nd, 1851, June 2nd-19th, 1852, at Beckenham, May 3rd, 1853, June 22nd, 1877, June 4th-9th, 1878, at Lewisham. He also bred imagines on April 15th and May 17th, 1853, from larvæ found at Lewisham. Threlfall bred imagines May 25th-June 1st, 1878, from larvæ obtained at Grange, October 13th, 1877.

Localities.—Berks: Reading (Hamm). Cambridge: Cambridge, very common (Farren). Cheshire: Birkenhead (Stainton). Derby: Burton (Sang). Dorset: Bloxworth (Cambridge), Purbeck, Glanvilles Wootton, Weymouth (Bankes). Durham: Darlington (Stainton). Gloucester: Bristol (Stainton). Hereford: Tarrington (Wood), Hereford (Chapman), Leominster (Hutchinson). Kent: Lewisham, Pembury (Stainton), Northfleet (Elisha), Chislehurst (Bower), Chattenden (Tutt). Lancashire: common everywhere in the county (Ellis), Manchester (Stainton), Grange (Threlfall). Leicester: Market Harborough (Matthews). Norfolk: Merton, Norwich, common (Barrett), King's Lynn, very abundant (Atmore). Northumberland: Newcastle (Stainton). Suffolk: Tuddenham, swarming (Warren). Surrey: Redhill (Chapman), Haslemere (Barrett). Sussex: abundant, Worthing, Abbott's Wood, etc. (Fletcher), Lewes (Stainton), Guestling (Bloomfield). Yorkshire: Scarborough (Wilkinson), Askham Bog, York (Hind), Doncaster (Corbett), Richmond (Sang), Sheffield (Doncaster).

Distribution.—Austria: Vienna, Fiume (Mann). France: Cannes (Millière), Nohant (Sand). Germany: generally distributed (Heinemann and Wocke), Alsace (Peyerimhoft), Frankfort-on-Main (Heyden), Hamburg, Hanover, Misdroy (Sorhagen). Italy: Istria, ? Nizzardo, Liguria (Curò). Netherlands: not rare (Snellen). Russia: Pargas, nr. Åbo, Aland (Reuter). Scandinavia: Scania (Wallengren). Switzerland: Bremgarten (Boll), Zürich (Frey).

Errata and Addenda.—p. 183, line 24, for "Bradenburg" read "Brandenburg." p. 199, line 7, for "agrees" read "does not agree." p. 275, line 7, delete "Fletcher." p. 285, line 20, for "Sorhagan" read "Sorhagen."

p. 184, line 14: "Mr. Vine informs us that he never bred the insects here referred to as *N. bistrimaculella*, but swept them from birches, many small oaks growing in the locality, and that he has now no doubt that the specimens so referred are *N. subbimaculella*."

p. 186, last line, and throughout genus, for "Nohaut" read "Nohant."

p. 297, line 14, add: "Durrant considers the species double-brooded. He found mines and larvæ in June and again in October, 1897, at Merton."

p. 297, par. 4, add: "Durrant notes that it is difficult to distinguish worn specimens of *N. basalella* and *N. turicella* by relying wholly on the markings. *N. basalella*, however, has an expansible tuft of dark hair-scales arising from the base of the hind-wing, whilst *N. turicella* has an ovate purplish-black patch towards the base of the fore-wings on the underside."

p. 269, par. 3, add: Spain: Barcelona dist. (Martorell).

p. 336, par. 7, add: Hereford: Woolhope (Wood).

Genus: TRIFURCULA, Zeller.

Synonymy.—Genus: *Trifurcula*, Zell., "Linn. Ent.," iii., p. 330 (1848); "Trans. Ent. Soc. Lond.," v., p. 138 (1848); Sta., "Cat. Brit. Tin.," etc., p. 30 (1849); "Ins. Brit.," p. 306 (1854); "Man.," ii., p. 438 (1859); H.-Sch., "Sys. Bearb.," v., p. 359 (1855); Frey, "Die Tineen," etc., p. 395 (1856): "Die Lep. der Schweiz," p. 426 (1880); Mann, "Wien. Ent. Monats.," vi., p. 407 (1862); Staud. and Wocke, "Cat.," p. 335 (1871); Mill., "Cat. Lep. Alp. Mar.," p. 174 (1875); Hein. and Wocke, "Schmett. Deutsch.," ii., p. 726 (1877); Snellen, "De Vlinders," etc., p. 966 (1882); Sorhagen, "Die Kleinschmett. Brandbg.," p. 301 (1886); Meyr., "Handbook," etc., p. 727 (1895). *Lyonetia*, Zell., "Isis," p. 214, in part (1839).

Zeller cites under this genus, the species *pallidella*, Zell., and *immundella*, Zell., referring, however, to figs. 51, 52 (= *T. pallidella*) to illustrate his diagnosis. This constitutes *pallidella* the type of the genus. Zeller's diagnosis (*Linn. Ent.*, iii., p. 330) of the genus is as follows:—

"Caput lanatum, etiam in epistomio. Antennæ breviusculæ, nudæ, conchula modica instructæ. Palpi breves, penduli. Alæ anteriores grosse squamatæ, cellula discoidali nulla; vena subcostali furcata, mediana arcuata in tres ramos divisa, subdorsali simplici longa. Posteriores: vena mediana in tres ramos divisa, subdorsali (?) longiuscula."

The main characters of the genus would appear to be as follows:—

Imago.—Head hairy; tongue rudimentary; antennæ simple, naked, the basal joint furnished with an eye-cap; maxillary palpi rather long, filiform and folded; labial palpi short, filiform; fore-wings lanceolate, coarsely scaled; hind-wings lanceolate.

Pupa.—Unknown.

Larva.—Practically unknown. Mining leaves and twigs of leguminous herbaceous plants (Glitz).

Ovum.—Unknown.

This small genus is unknown outside Europe and Asia Minor. Besides the three British species, only *T. serotinella*, a species that has been captured in Bavaria and Norway, and *T. confertella*, Fuchs (*Stett. Ent. Zeit.*, lvi., pp. 47-48, 1895), from Loreley, in June, are known to science.

TRIFURCULA IMMUNDELLA, Zeller.

Synonymy.—Species: *Immundella*, Zell., "Isis," 1839, p. 215; "Schles. Tausch-ber.," iv., p. 21 (1843); Ibid., vi., p. 16 (1845); "Linn. Ent.," iii., p. 332 (1848); Sta., "Trans. Ent. Soc. Lond.," v., p. 139 (1848); "Ins. Brit.," p. 307 (1854); "Man.," ii., p. 438 (1859); "Ent. Ann.," 1862, p. 140; "Ent. Ann.," 1874, p. 51; H.-Sch., "Sys. Bearb.," pl. 108, fig. 861 (1853); v., p. 359 (1855); Frey, "Die Tineen," etc., p. 396 (1856); "Die Lep. der Schweiz," p. 426 (1880); Staud. and Wocke, "Cat.," p. 335 (1871); Hein. and Wocke, "Schmett. Deutsch.," p. 726 (1877); Snellen, "De Vlinders," etc., p. 967 (1882); Sorhagen, "Die Kleinschmett. Brandbg.," pp. 301 and 344 (1886); Meyr., "Handbook," etc., p. 727 (1895).

Original description.—*Lyonetia immundella*, Zell., von *L. cristatella* dadurch verschieden, dass in die silbergraue Farbe der Vorderflügel grobe, bräunliche Schuppen eingemischt und die Kopfhaare bräunlich sind; die Augendeckel schmutzig gelblichweiss. 9 Ex. bei Glogau am 8ten Juni Abends an *Spartium scoparium* gefangen (Zeller, *Isis*, 1839, p. 215).

Imago.—Head yellowish (sometimes violet, Sta.). Anterior wings 7-8 mm., whitish, dusted with grey scales throughout; cilia whitish. Posterior wings pale grey, cilia yellowish.

Variation.—*a.* var. *squamatella*, Sta., "Cat.," p. 30 (1849); "Ins. Brit.," p. 307 (1854); "Man.," ii., p. 438 (1859); H.-Sch., "Sys. Bearb.," v., p. 360 (1855); Staud. and Wocke, "Cat.," p. 335 (1871).—Head yellowish. Anterior wings 8 mm. in expanse; yellowish-white, dusted with coarse dark grey scales; the costa and inner margin less suffused; a slender curved line along the disc, uninterruptedly whitish; cilia yellowish-white. Posterior wings grey, with yellowish cilia.

Stainton, after describing this insect, notes that "*T. immundella* is much less than *T. squamatella*; the anterior wings darker; head purplish-grey; posterior wings with grey cilia." He further remarks (*Ins. Brit.*, p. 307), that the few known specimens "occurred among broom in August, in company with *T. immundella*, of which it is perhaps a variety." Bankes has examined Stainton's type specimens, and considers it "certainly only a form of *T. immundella*." The type specimens were captured by Bedell and Sircom, and others by Stainton, on August 9th and 20th, 1849, at Charlton. Sircom's specimens came from Bristol, and Wilkinson afterwards recorded others from

Scarborough. Bower has one belonging to this form from Brandon, taken July 20th, 1878.

LARVA.—The larva burrows under the bark of broom, and is full-fed in April, or early in May. It assumes the pupal state within its burrow, the imago not appearing before the middle of July (Glitz). Warren notes that "at end of May he beat out many fat, bright, amber larvæ, which were evidently full-fed, and on the point of spinning up, and found the smaller broom leaves along the twigs eaten out and whitened by the larvæ: one leaf is not enough for them, and they mine from one to another beneath the cuticle of the stem" (*in litt.*, December 1st, 1889).

FOOD-PLANT.—*Cytisus scoparius* (Glitz).

TIME OF APPEARANCE.—This species appears to be double-brooded, imagines occurring in June, and again in July-August. Stainton captured specimens, always among broom, on July 15th, 1848, and July 16th, 1880, at the Bridge of Allan, July 10th, 1880, at Pitlochry, July 18th, 1848, *in cop.*, at Torwood, July 6th-11th, 1849, at Mickleham, August 9th, 1849, and August 3rd, 1850, at Charlton. Zeller captured imagines June 8th, 1848, at Glogau, and Mann, in the middle of June, at Pratovecchio, but Frey gives the end of July for a single capture he made near Würenlos. Fletcher obtained the species freely in broom coverts, nr. Thetford, in August, 1884, and at Burgess Hill, on July 28th, 1894. Bower notes July 29th, 1889 (seven specimens), August 5th, 1891, August 8th, 1892, and June 19th-26th, 1893 (common), also August 15th, 1895, August 4th, 1897, at Lee, among broom. Sang made captures at Darlington on July 5th, 1857, July 7th, 1861, July 27th, 1874, and August 8th, 1879 (*teste*, Gardner). Bankes found it from August 19th-31st, 1889, at Purbeck, whilst Evans met with it on the Braid Hills on June 30th, and again on August 18th, 1894, at Tynefield. Warren gives it as taken abundantly in the first half of August, by beating the lower parts of broom bushes into an umbrella, whilst Bankes bred the insect from June 20th-24th, 1890, from moss received from Perth, in May, 1890, broom growing where the moss was collected.

LOCALITIES.—CHESHIRE: Crewe (Thompson). DORSET: Purbeck (Bankes). DURHAM: Darlington (Sang). EDINBURGH: Braid Hills (Evans). GLOUCESTER: Bristol (Stainton). HEREFORD: Woolhope (Wood). KENT: Charlton, Dartford Heath (Stainton), Lee (Bower). LOTHIAN (EAST): Tynefield (Evans). MIDDLESEX: Hampstead Heath (Warren). NORFOLK: nr. Thetford (Fletcher). PERTH: Perth (Bankes), Torwood, Pitlochry (Stainton). STIRLING: Airthrey, Bridge of Allan (Stainton). SUFFOLK: Brandon (Barrett). SURREY: Mickleham (Stainton). SUSSEX: Burgess Hill (Fletcher). YORKSHIRE: Scarborough (Wilkinson).

DISTRIBUTION.—Africa (North) (Meyrick). Austria: Bohemia, nr. Reichstadt (Fischer-v.-Röslerstamm). Germany: Glogau (Zeller), Hamburg, Stettin, Hanover (Sorhagen). Italy: Tuscany, Pratovecchio in the Apennines (Mann). Netherlands: South Holland, Gelderland, Arnhem, Groenlo, Overijssel, Raalte (Snellen). Switzerland: Würenlos, nr. Zürich (Frey).

TRIFURCULA PALLIDELLA, Zeller.

SYNONYMY.—Species: *Pallidella*, Zell., "Linn. Ent.," iii., p. 332, figs. 51-52 (1848); Sta. and Zell., "Trans. Ent. Soc. Lond.," v., p. 138 (1848); H.-Sch., "Sys. Bearb.," v., p. 359 (1855); Staud. and Wocke, "Cat.," p. 335 (1871); Krause, "Stett. Ent. Zeit.," xxxii., p. 304 (1871); Mill., "Cat. Lep. Alp. Mar.," p. 174 (1875); Hein. and Wocke, "Schmett. Deutsch.," ii., p. 726 (1877); Hodg., "Ent. Mo. Mag.," xvi., p. 186 (1880); Sorhgn., "Die Kleinschmett. Brandbg.," p. 343 (1886); Griffith, "Ent. Mo. Mag.," xxii., p. 65 (1886); Bankes, "Ent. Mo. Mag.," xxv., p. 445 (1889); Meyr., "Handbook," etc., p. 727 (1895). *Pallidulella*, H.-Sch., "Sys. Bearb.," fig. 860 (1853).

ORIGINAL DESCRIPTION.—*Pallidella*, F.-R., nov. sp. (figs. 51-52).—Alis anterioribus exalbidis, obscurius grosse squamatis; posterioribus cinerascentibus, exalbido-ciliatis. Grösser als die folgende (*T. immundella*), wie eine *Cem. spartifoliella*. Der Körper bleich gelblich glänzend, Hinterleib grau, am Rande und Bauche weisslichgelb beschuppt. Schopf auf dem Scheitel blassrostgelb; Fühler hellgrau, bleichgelblich beschuppt und schimmernd. Flügel seidenglänzend; die vordern auf beiden Flächen sehr bleichgelblichweiss, auf der Oberseite mit groben, sehr blassochergelben, gegen die Spitze reichlicheren Schuppen. Die Flügelspitze ist auf den Franzen von einem solchen Schuppenringe eingefasst. Hinterflügel durchsichtiger, sehr hellgrau mit gelblichen Franzen (Zeller, *Linnaea Entomologica*, iii., p. 332).

IMAGO.—Head rough, rusty-yellowish. Anterior wings 8 mm. in expanse; unicolorous yellowish-white in colour, irrorated with large ochreous scales. Posterior wings pale grey, with yellowish fringes.

SEXUAL DIMORPHISM.—The females are considerably darker, both fore- and hind-wings, than the males (Bankes).

LIFE-HISTORY.—Quite unknown, although the larva probably feeds under the bark of the twigs of *Genista tinctoria*, and allied plants.

FOOD-PLANTS.—? *Genista tinctoria* (Stainton), ? *Genista sagittalis* (Zeller), ? *Genista germanica* (Wocke), ? *Cytisus* (Krause).

TIME OF APPEARANCE.—The species appears to be double-brooded, imagines appearing May-June and August-September, although Krause captured, besides the two regular broods, a specimen on July 3rd, 1868, at Altenburg, whilst Fletcher took one on July 3rd, 1890, near Brighton, and Bankes two, worn, on July 3rd, 1893, at Purbeck. Mann captured specimens on May 19th, 1846, at Pisa, in marshes, among low bushes and grass, in May, 1851, at Brussa, in Asia Minor, in May, 1853, at Fiume, in a little ash wood behind the Pulverthurm, in May, 1854, in a pasture-field, at Oberfeld, in Carniola, and in May, 1858, he took two specimens in Sicily. Millière notes it as occurring at Cannes in April. Krause notes the species at Altenburg, in two generations, from the commencement to the middle of June, and the commencement of September; it occurs here in a very confined locality, the upper cliffs of a disused gravel-pit. He notes that Zeller and Rössler consider the species to be confined to moist localities, but this is dry, and covered with heather, scabious, etc., among which the moths fly as soon as the sun goes down. Hodgkinson notes it as flying at Dutton, at the end of August, from 7 a.m.-9 a.m. Fletcher obtained it freely near Brighton, at end of August and commencement of September, in 1890, among *Genista tinctoria*. Bankes took it freely in a rough pasture, from September 5th-19th, 1889, at Purbeck, the males flying, on calm evenings, for half-an-hour at sunset, the females seated on the herbage, the males sometimes assembling to them when newly emerged; also August 28th-September 19th, 1890, September 8th-October 3rd, 1891, August 17th-September 10th, 1892, August 7th-29th, 1893, August 28th-September 1st, 1894, August 11th, 1898. Dale records it from Glanvilles Wootton on September 2nd, 1888.

LOCALITIES. — DORSET: Purbeck (Bankes), Glanvilles Wootton (Dale). HEREFORD: Woolhope (Wood). HERTS: Sandridge, nr. St. Alban's (Griffith).

LANCASHIRE : Preston (Hodgkinson). SUSSEX : nr. Brighton (Fletcher). WESTMORLAND (? LANCS) : Dutton (Hodgkinson).

DISTRIBUTION.—Asia Minor : Brussa (Mann). Austria : nr. Vienna (Zeller), Oberfeld in Carniola, Fiume (Mann), Carinthian Alps, nr. Steltzing, at 4,500 feet above the sea (Zeller). France : Cannes, pentés boisées et herbues des Vallergues, du Vallon des Tignes, etc. (Millière). Germany : Altenburg (Krause), Silesia (Wocke), Hanover (Sorhagen), Ratisbon (Herrich-Schäffer). Italy : Tivoli, Pisa, Pallagutta valley in Sicily (Mann).

TRIFURCULA ATRIFONTELLA, Stainton.

SYNONYMY.—Species: *Atrifrontella*, Sta., "Supp. Cat. Tin.," p. 11 (1851); "Ins. Brit.," p. 306 (1854); "Man.," ii., p. 438 (1859); H.-Sch., "Sys. Bearb.," v., p. 360 (1855); Staud. and Wocke, "Cat.," p. 335 (1871); Hein. and Wocke, "Schmett. Deutsch.," p. 726 (1877); Hartm., "M. T. Münch. Ent. Ver.," iv., 59, no. 2973 (1880); Threlfall, "Ent. Mo. Mag.," xvi., p. 230 (1880); Sorhgn., "Die Kleinschmett. Brandbg.," p. 344 (1886); Meyr., "Handbook," etc., p. 727 (1895).

ORIGINAL DESCRIPTION.—*Atrifontella*, n. sp. Expanse 4 lines. Anterior wings ochreous, almost entirely suffused with coarse dark grey scales; head black. Two specimens in Mr. Bedell's collection (*Supplementary Catalogue of British Tineidae and Pterophoridae*, p. 11).

IMAGO.—Head black. Anterior wings 8 mm. in expanse : yellowish-white, almost entirely suffused with dark fuscous scales, the base of costa remaining of ground colour; cilia greyish. Posterior wings pale grey, with paler cilia.

LIFE-HISTORY.—Threlfall notes (*E.M.M.*, xvi., p. 230) that he bred, in June, 1879, a specimen of this species from hawthorn leaves collected the previous October, probably from blotch-mines, which he noticed as differing from those of *N. pygmaeella* and *N. ignobilella*. Sorhagen says : " Larva in April and May, under the bark of *Genista* (Glitz)," which is possibly an error, or Glitz may have made a mistake in the identification. If Threlfall be correct, the species undoubtedly wants removing to *Nepticula*, with *N. pulverosella* ; if Glitz be correct, then it is probably rightly placed here.

FOOD-PLANT.—Doubtful : ? *Crataegus oxyacantha* (Threlfall), *Genista* (Glitz).

TIME OF APPEARANCE.—The species appears to be double-brooded, imagines appearing in June and August. Stainton obtained an imago, beaten from oak, on August 13th, 1851, at Lewisham. Barrett records it as occurring on oak-trunks at Haslemere, in August, 1864, and Bower, on a fence, at Bexley, August 12th, 1892. Cambridge notes the species as flying in a wood at Bloxworth, at the end of June, 1889, and he captured another at the commencement of August, 1891, whilst Threlfall reports breeding the species in June, 1879, from hawthorn. Heinemann and Wocke note it as occurring at the end of July and in August, at Breslau, and in Saxony.

LOCALITIES.—DORSET : Bloxworth (Cambridge). KENT : Lewisham (Stainton), Bexley (Bower). LANCASHIRE : Preston (Threlfall). SURREY : Haslemere (Barrett).

DISTRIBUTION.—Germany : Breslau and Saxony (Heinemann and Wocke), Hanover (Sorhagen).

Genus : SCOLIAULA, Meyrick.

SYNONYMY.—Genus : *Scoliaula*, Meyr., "Handbook," etc., p. 727 (1895). *Nepticula*, Boheman, "Ent. Ant.," etc., p. 167 (1851); Sta., "Proc. Ent. Soc. Lond.," ser. 2, iii., p. 18 (1854). *Bohemannia*, "Man.," ii., p. 439 (1859); H.-Sch., "Sys. Bearb.," v., p. 353 (1855): Staud. and Wocke, "Cat.," p. 340 (1871); Millière, "Cat. Lep. Alp. Mar.," p. 372 (1875). *Opostega*, Warren, "Ent. Mo. Mag.," xxv., p. 145 (1888).

The name *Bohemannia* is pre-occupied in Hemiptera by Stâl, 1855. The genus *Scoliaula* is diagnosed (*Handbook*, p. 727) by Meyrick as follows:—

Head rough. Tongue rudimentary. Antennæ ⅔, in ♂ simple, basal joint enlarged and concave beneath to form eye-cap. Labial palpi short, filiform, rather drooping. Maxillary palpi long, filiform, folded. Posterior tibiæ with bristles above; middle-spurs slightly above middle. Neuration of fore-wings: 1b simple, lower margin of cell obsolete, upper margin curved downwards below middle of disc, 2 absent, 3 absent, 4-7 appearing to rise out of 8, 9 absent. Hind-wings over ½, lanceolate, cilia 2½; cell open between 2 and 6, 3-5 absent.

Of the only species known belonging to this genus, Stainton wrote (*Insecta Britannica*, p. 306): "This singular insect, taken by Boyd, among alders in the New Forest, last summer, I cannot consider lepidopterous, though so completely Nepticulid in form. Its longer antennæ, longer legs, differently-shaped broader posterior wings, and neuration of the anterior and posterior wings, would clearly place it in a distinct genus, if admitted as lepidopterous, but the more polished appearance of the anterior wings and its general facies, induce me to think it trichopterous. Many of the smaller Trichoptera are continually being mistaken for Tineina, but, except in the present instance, I am not aware that any difficulty has been found in ultimately distinguishing them." Meyrick considers this as "closely approaching the common ancestral form of the two preceding genera," and it retains considerable resemblance to a Trichopterygid ancestor, as Stainton has pointed out.

SCOLIAULA QUADRIMACULELLA, Boheman.

SYNONYMY.—Species: *Quadrimaculella*, Boh., "Ent. Anteckn. under en resa i Södra Sverige," 1851, p. 167; Sta., "Proc. Ent. Soc. Lond.," ser. 2., iii., p. 18 (1854); "Man.," ii., p. 439 (1859); Staud. and Wocke, "Cat.," p. 340 (1871); Mill., "Cat. Lep. Alp. Mar.," p. 372 (1875); Wallgrn., "Ent. Tids.," ii., p. 131 (1881); Boyd, "Ent. Mo. Mag.," xxiv., p. 187 (1888); Warren, "Ent. Mo. Mag.," xxv., p. 145 (1888); Meyr., "Handbook," p. 728 (1895).

ORIGINAL DESCRIPTION.—*Nepticula quadrimaculella*: Capillis lutescentibus; antennis nigro-fuscis, apice argenteis; alis anterioribus cupreo-purpurascentibus, singula pone medium maculis duabus, sat magnis, oppositis, una in margine exteriore, altera in margine interiore, dilute flavescentibus, aureomicantibus, fimbriis longis fuscis; alis posterioribus nigro-fuscis. Long. al. exp. 5-7 mm. In Coryletis ad Kullen d. 15-19 Aug. individua nonnulla legi (Boheman, *Entomologiska Anteckningar under en resa i Södra Sverige*, 1851, p. 67). A detailed Latin description follows this diagnosis.

IMAGO.—Head reddish. Anterior wings purplish-coppery, with a pale yellow spot on inner margin beyond the middle, another on costa rather beyond it. Posterior wings dark fuscous.

FOOD-PLANT.—? Flowers and flower-stalks of alder, in spring (Warren).

TIME OF APPEARANCE.—The imagines fly in July and August. Barrett found them in the fens round Norwich when sweeping alders, in August, 1872; Atmore obtained specimens in July, 1882, at King's Lynn; Boyd, in August, 1887, flying in sun among alders, at Lowestoft. Cambridge beat imagines from alder, from July 26th-

August 21st, 1892, at Bloxworth; and Barrett swept about a dozen from alder on July 31st, 1869, at Ranworth. Millière strangely records it as occurring in May, at light, at Cannes.

Localities.—Dorset: Bloxworth (Cambridge), Glanvilles Wootton (Dale). Durham: Darlington (Sang). Hants: Lyndhurst (Boyd), New Forest (Digby). Hereford: Woolhope (Wood). Lancashire: Preston (Threlfall). Norfolk: Norwich (Barrett), King's Lynn (Atmore), Ranworth (Barrett). Suffolk: nr. Lowestoft (Boyd). Yorks: Scarborough, common (Wilkinson), Wheatley Wood, nr. Doncaster (Corbett).

Distribution.—France: Cannes (Millière). Scandinavia: South Sweden (Boheman), Kullaberg (Wallengren).

Superfamily III: COCHLIDIDES (= EUCLEIDES).

This superfamily consists of two well-marked families, the *Eucleidae* and *Cochlididae*. In the earlier part of this volume we have called the superfamily Eucleides, but we are now authoritatively informed that the correct name to use is Cochlidides. Walsingham has shown that the *Tentamen* names of Hübner were published at least by 1806. *Cochlidion*, therefore, becomes the correct generic name for *avellana* (*testudo*), which is stated to be the type of the family, etc., the correct family name for the species allied to *C. avellana* being *Cochlididae*, and the superfamily including it, Cochlidides. It is to be hoped that no further change may be necessary before this volume is finished. Kirby remarks that *Cochlidion*, *Apoda* and *Limacodes* are co-typical and, therefore, absolutely synonymous.

The above explanation may make a note on the leading group names advisable. In 1802 (*Hist. Nat.*, iii., p. 407), Latreille included the group under the name *Apodes*. In 1806 (*Tentamen*) Hübner designated *Cochlidia* as a group name, but without diagnosis, and about 1822 (*Verz.*, pp. 397-398), he constructed the family (stirps) name *Cochlidiae*. In 1829 (*Ind. Meth.*, p. 57), Boisduval applied the term *Cocliopodi* (genus: *Limacodes*) to these insects, a name followed by Herrich-Schäffer, and in 1840 (*Gen. et Ind.*, p. 81) diagnosed the group under the name *Cocliopodes*, corrected by Agassiz (*Nom. Zool.*, Index, p. 92) in 1846 into *Cochliopodes*. Stephens, in 1835 (*Illus.*, iv., p. 420), modified Hübner's name into *Cochlidae*, whilst Stainton, in 1857 (*Man.*, i., p. 168), modified Boisduval's title into *Cochliopodae*, and Staudinger, in 1871 (*Cat.*, p. 62), altered it to *Cochliopodidae*. In 1844 (*Cat.*, p. 84), Duponchel, apparently utilising Latreille's name *Limacode* (*Fam. Nat.*, p. 474), renamed the group *Limacodidae*, a name since adopted by Kirby. In 1894 (*Journ. New York Ent. Soc.*, p. 173), Neumoegen and Dyar called the family *Eucleidae*, because "the generic names *Limacodes* and *Cochlidion* have become synonymous." In 1895 (*Handbook*, p. 224) Meyrick renamed the group *Heterogeneidae*, and in the same year (*Sys. Nat. Hildesiae*, p. 3) Grote called it *Apodidae*. We have now reverted to Hübner's name, *Cochlidia*, which is modified so as to meet modern views that all family terminations should end in "idae," and superfamily terminations in "ides."

It will be understood from the above that various authors have used the terms Cochliopodids, Limacodids, Heterogeneids, and Eucleids in precisely the same sense, and that these names have comprised the species included in this superfamily as a whole. To prevent confusion, we have adhered mainly in this chapter to the term "Eucleid" when used in this comprehensive sense, this name having been thus applied in all the earlier chapters of this volume.

The Cochlidids, known more generally as Cochliopodids and Limacodids in Europe, and Eucleids in America, are, in some respects, among the most generalised of Lepidoptera. They are more closely allied to the Megalopygids than to any other superfamily, and Packard considers that they have also affinities with the Saturniids. The eggs and pupæ of the Eucleids (Cochlidids) and Megalopygids are certainly very similar, the pupæ being of a very generalised type. Their larvæ, however, are different, and the absence of abdominal prolegs in the former separates them very sharply from their congeners. Packard calls the Megalopygid larva of *Lagoa crispata* "a primitive Cochliopodid with larval abdominal legs." The same author's suggestion of a Saturniid alliance, seems to have been obtained chiefly from the larvæ of *Adoneta* and *Empretia*, whose large tubercles, bearing three radiating setæ or bristles, remind one much of those of the Saturniids. Packard considers that the oldest and least modified forms are the tuberculated larvæ of *Euclea*, *Adoneta* and *Empretia*, these being "more like the larvæ of other Bombyces." On the other hand, he says, the nearly smooth slug-worms, without hairs or tubercles when fully grown (such as *Apoda* or *Heterogenea*), appear to be the most aberrant, having lost their prolegs by disuse, the thoracic ones also being greatly reduced in size, while their sluggish disposition, their slow gliding mode of progression, and their peculiar coloration, have produced the most strange and bizarre type of lepidopterous larva in existence.

Chapman insists very strongly on the relationship existing between this superfamily and the Nepticulids, which do not, superficially, bear the slightest resemblance to each other. Apart from the matter of size, the larvæ of the Cochlidids (Limacodids) are external feeders, those of the latter are miners. The neuration of the former is generalised, that of the latter extremely specialised, owing to the minute size of the moths. Chapman, however, asserts that the pupæ are structurally identical. The delicate pupal skin, the free abdominal segments, the easily separable appendages, the arrangement of the dorsal spines in several rows of small equal points towards the dorsal margin of each segment, the strongly developed maxillary palpus, the mode of emergence from the cocoon, are all points of similarity that exist in the pupæ. Certain larval and imaginal characters also show considerable resemblance in the two groups—the modification of the prolegs, the method of larval progression, etc., will at once occur to all lepidopterists.

Speyer was the first to point out an alliance between the Cochlidids (Eucleids) and the Anthrocerids. He based this conclusion mainly on their generalised structure, the delicate pupal integument, and the partially loose sheath of the pupa. He considered that these groups stood nearest to the Tineids with complete maxillary palpi, which he believed formed the oldest branch of the lepidopterous stem. Chapman also considers that they are somewhat closely allied, and have been evolved from a common stem.

Packard has recently practically adopted Chapman's views as to the inter-relationship existing between the Micropterygids, Nepticulids, Megalopygids, Cochlidids (Eucleids), etc. After noting that Chapman removes the Cochlidids from the Bombyces proper after a study of their larval and pupal characters, he states that this superfamily and the Megalopygids should be placed near the Tineoids, from which they have, undoubtedly, descended, but he adds: "That the line of descent was directly from the *Eriocephalidae*, as Chapman suggests, seems to us a matter of doubt, for the larvæ of the Cochliopodids present some notable differences from that of *Eriocephala*, whose so-called 'eight pairs of abdominal legs' appear to be merely spine-bearing tubercles. . . . . If we compare the head of the pupa of *Parasa* and those of other genera, especially *Limacodes* (*Cochlidion*) and *Heterogenea*, with that of *Tinea*, there will be observed a close resemblance, especially in the maxillæ, maxillary palpi, and labial palpi, indicating the more or less direct descent of the family from some Tineid form, perhaps an extinct ally of *Nepticula*, since Chapman speaks of a resemblance that is almost identity in the pupa of *Nepticula* as compared with that of *Limacodes*." The probable alliance between the Micropterygids and Cochlidids (Eucleids) has been previously mentioned (*ante*, pp. 135-136), as also that between the latter and the Nepticulids (*ante*, p. 180).

The Cochlidid (Eucleid) egg is a flat, oval, colourless speck, very similar to those of the Nepticulids and Megalopygids. It is exceedingly thin, transparent, membranous, with a cell-structure forming a lozenge-shaped network, covering the surface of the shell (easily seen if examined in suitable light, and with moderate magnifying power). It is quite naked, and not covered with silky hairs, as are the eggs of *Lagoa*, one of the Megalopygids. It is, indeed, just what one might have expected the generalised flat egg of this stirps to be. Chapman says that somewhat similar eggs occur amongst certain Tineids and Pyrales.

The larva is without abdominal prolegs, those of our British species being provided with suckers to the first eight abdominal segments, the first and last, however, poorly developed. Their appearance, however, suggests that they are homologous with prolegs, and with the special structures occupying the position of the latter in Micropterygids (*ante*, p. 141). The Cochlidid (Eucleid) larva is, in a great degree, a generalised larva, with much plasticity (variability), and a tendency to specialisation in its remarkable armatures. The larvæ of our British species show their specialisation in their shape, mode of progression. and colour, and not in the development of prominent spines or hairy warts, as is the case in the larvæ of certain exotic species. This specialisation is most probably for protective purposes. The larvæ appear to be protected: (1) By the way the body is appressed to the leaf, its expanded edges appearing to merge, owing to their closeness and similar colour, into the surface of the leaf. (2) By their peculiar red and brown markings on a green ground, which, added to their humped shape, make them closely resemble the galls so frequently formed on the surfaces of leaves. (3) By their almost imperceptible gliding motion, which is less likely to attract attention than would the movements of a more rapidly travelling larva. The specialisation of the British species is especially notable, then, from the fact that the larvæ have lost their armature in the adult stage, a specialisation that is really more extreme, in a sense, than that of the possessors of the most remarkable, abundant, and bizarre armature.

Our European species, however, give us no idea of the marvellous modification to which the larvæ are subjected in other parts of the world. Roughly, those of the exotic species fall into two main divisions: (1) Bearing tubercles and spines. (2) Smooth and unarmed. Some belonging to the first group have spines of a peculiarly urticating nature. The second are not very dissimilar from those of our European species. The newly-hatched larvæ of both groups are without abdominal prolegs, and we can readily understand that the differences observed in the adult forms, are the result of a response to differing stimuli and environment. Dyar says that the Eucleid larvæ have, in their most generalised forms, only two rows of tubercles present, the subdorsal and the superstigmatal; the substigmatal row, present in the *Megalopygidae* and *Pyromorphidae* have here disappeared. The modification of the tubercles into fleshy horns, and the setæ into urticating spines, have produced the "tuberculated or spiny" group, whilst the reduction and disappearance of the tubercles have produced the "smooth or unarmed" group. The "spiny" larvæ have also developed bright and warning colours, whilst the "smooth" larvæ are either green or so coloured that their hues aid effectually in their concealment. On the other hand, Chapman has shown that the so-called "smooth" Cochlidid larva, as represented by our European species, has a double dorsal row of evaginated spines, placed alternately on successive segments .·.·., and a lateral row on either side of the body, in the first skin (*Trans. Ent. Soc. Lond.*, 1894, pp. 345-347). He has also shown that, in the second skin, these spines become pointed hairs, with an internal tubular structure (differentiating them from hairs, though their terminal process may be a hair homologous with those carried by ordinary tubercles), the dorsal ones on abdominal segments now double, *i.e.*, formed of two spines originating close together : : : : :, and thus completing the double row, of which only the alternate members are present in the first skin. In the third skin the bases of the spines are surronnded by minute spinules, each with a coronet-like apex. In the fourth skin the small spines at the base of the large central ones are less obvious, the whole skin surface being now covered with minute spikelets, whilst there also appear to be some minute glandular structures placed dorsally and dorso-laterally on each segment. With the fifth skin the spines disappear, and the larva now, in reality, becomes smooth. The evaginated dorsal spines of *H. cruciata*, although arranged first alternately and then in a double row, as in *C. avellana* (*testudo*), differ from those of the latter (described above) in having two branches. These are fully described later in our account of the species.

Packard says that the Eucleid larvæ are nearly colourless when newly hatched, and that their bodies are more cylindrical than in the full-grown caterpillar. The larvæ of the more specialised tuberculated and spiny genera *Adoneta* and *Empretia* (and probably *Euclea*) have the tubercles already differentiated in the first stage, but the change from the first to the second stage is very great, owing to the development of large numbers of bristles upon the tubercles, and the gay varied colours and markings of the body. The armature of poisonous glandular spines and the development of bright warning colours are, he considers, evidently characters acquired late in larval life, when the creatures are large enough to attract notice.

The larvæ of the Australian species are, however, the most remarkable, and one of the strangest of these is that of *Doratifera vulnerans*, figured by Lewin. It is described as having the power to evert eight little tufts of stinging spines, which are concealed when the larva is not irritated. Dyar states that this larva seems to be the most specialised form of the "spiny" type, and that those of four other species examined exhibited a gradation from that of *D. vulnerans*, with strongly eversible spines, to the smooth form. It appears probable to us that the Australian forms are in this group, as in others, the oldest we have, except that the hairy forms may be earlier as being related to the Megalopygids (*Lagoa*), which also may be earlier than the Cochlidids (Eucleids). If this were so, the larva of our British species *Cochlidion* (*Limacodes*) *avellana*, with its eversible spines on hatching, would represent in its first skin, the adult larva of *Doratifera*. It would also in its third skin, with subsidiary spines, represent the latter forms with fixed spines, and give, as the most recently evolved form, a smooth larva. If any forms become smooth in the second stage they would, of course, on this supposition, be older still, but at present there appear to be no individuals known with smoother larvæ than those of our British species.

Dyar explains the structure of the Eucleid larva by reference to the Anthrocerid type (*Psyche*, viii., pp. 171-174). Every British lepidopterist will know that after the first moult the Anthrocerid larva has, on either side of each segment, three complex warts, as follows: (1) Subdorsal (formed from tubercles i and ii). (2) Supraspiracular (iii). (3) Subspiracular (iv and v). Dyar says that in the Eucleid larva the subventral area is reduced, owing to the formation of the creeping disc, and all the warts below the spiracular region are obsolete. Assuming the Anthrocerid larva to have retained in this particular the more primitive form, the extinction of the subspiracular tubercle in the manner shown would leave the primitive Eucleid form (as such) with three warts on each side of the thoracic, and two on each side of the abdominal segments.

The modification of these warts into their present forms is supposed, by Dyar, to have taken place in two ways: (1) By hypertrophy, which has resulted in producing the spined Eucleids. (2) By atrophy, which has resulted in the smooth forms. On these lines, Dyar subdivides the "hypertrophied" forms into two main larval "types": (1) The tropical hairy Eucleids (illustrated by *Phobetron* and *Calybia*), with a combination of general characters that suggests this as the most generalised Eucleid type. (2) The tropical spined Eucleids (illustrated by *Sibine*, *Euclea*, etc.), to which many of the Indian and South American species, figured by authors, belong. To this group Dyar refers the Australian species, which differ from those of Asia and America "in having the spines removed from the horns which have not become eversible," a peculiar specialisation which leads Dyar to consider the Australian type as the most modified of all Eucleid larvæ. The "atrophied" forms also, according to Dyar, fall into two main divisions: (1) The tropical smooth Eucleids (illustrated by *Eulimacodes*), which, starting with warts in the first stage, lose them by degeneration after the first moult, their place being taken by single setæ. (2) The Palæarctic smooth Eucleids [illustrated by *Cochlidion* (*Apoda*), *Heterogenea* and *Packardia*], in which, Dyar says, the single setæ of the first stage are retained and the warts have entirely disappeared, leaving an almost smooth larva. To this last type, the European species belong. Of course the spiny forms may have originated from a generalised Anthrocerid-like larva, but, we think, there can be little doubt, after reading Chapman's observations, that the smooth forms were developed from the spiny ones. We would also note, that from the second skin onwards, the larva of *Cochlidion* has a subspiracular hair on each segment.

This subdivision gives us a basis for a tentative arrangement of the superfamily, which may be stated as follows:

I. Fam. EUCLEIDÆ. (1) Subfam. *Phobetrinae.*—Larva in first stage with alternate strong and weak segments; thoracic segments with three (i, ii, iii), abdominal with two (i + ii, iii) tubercles bearing single setæ (above each spiracle). After first moult, strong and weak segments persistent; the tubercles changed to hairy (not spined) warts.

(2) Subfam. *Eucleinae.*—Larva in first stage not showing strong and weak segments; thoracic and abdominal segments with two tubercles bearing multiple setæ (above each spiracle). After first moult, the tubercles changed to spiny warts.

II. Fam. COCHLIDIDÆ. (1) Subfam. *Eulimacodinae.*—Larva in first stage with three warts on thoracic, and two on abdominal segments (above each spiracle). After first moult, the warts degenerate into single setæ.

(2) Subfam. *Cochlidinae.*—Larva in first stage with alternate strong and weak segments. Single alternate minute dorsal spines in first stage, double dorsal row in second, third and fourth skins, lateral row in first four skins; entirely absent after fourth moult.

We are much in doubt whether the distinctions between the *Eulimacodinae* and *Cochlidinae* really exist. We understand that the basis of Dyar's conclusions as to the strong and weak segments was founded on the alternate character of the dorsal spines. It has also been necessary for us to modify Dyar's definition that the *Cochlidinae* lose all their armature after the first moult, in accordance with Chapman's observations that they retain it in the first four skins. It is possible that the *Eulimacodinae* should be merged in the *Cochlidinae*, there being probably only one structural plan in the larvæ of the two groups.

The urticating property of the spines or setæ of certain Eucleid larvæ is well known, but the actual mode of injury has not been explained. Lewin states that the larva of *Doratifera vulnerans* darts out its fascicles of "stings" whenever it is alarmed by the approach of anything. The larvæ of the Javan *Parasa media* and *P. lepida* have also this urticating property developed in the highest degree, as, indeed, have the larvæ of many other species. Although spoken of as "stings," etc., it is probable that the urtication is caused, as in other lepidopterous larvæ, by the mechanical influence of the fine barbed setæ that enter the skin. The spines, however, often appear to be constructed like stings, *i.e.*, they are tubular with a brittle tip.

The larva spins a cocoon which is provided with an easily detached lid, the pupa being provided with a projecting beak, by which the lid is probably forced off. It is not "cut" in the true sense, nor is it prepared by the larva, but fractured somewhat irregularly. It is quite possible that the pupa works round and round, fracturing the lid bit by bit, but the beak has no cutting edge, and anything there is like one is at right angles to the line of fracture of the lid. In this particular, the lid of the Eucleid is different from that of the Megalopygid cocoon, which Lintner has shown to be woven (in *Lagoa crispata*) by the larva, separately from the rest of the cocoon, so that the lid, in this latter case, is not a section cut or broken from it after its completion. Generally speaking, the cocoons are brown or ochreous in colour, but those of *Calybia slossoniae* are chalky-white, conspicuous on the green leaves of the mangrove trees, but hard to detect on the whitish bark. The brown cocoons of *Cochlidion avellana*

(*Apoda testudo*) and *Heterogenea cruciata* are well protected on the dead leaves, to which they remain attached throughout the winter.

The pupa is of a very generalised type. The abdominal segments are all free, *i.e.*, they are not soldered to the wings and appendages, and appear to be capable of independent movement upon each other. It is probable, however, that the insect rarely does move them, being tightly packed in its cocoon. The maxillæ are small, but are prolonged outwards, and after passing through a narrow neck, terminate in a (sometimes rather twisted) club between the eyes, antennæ and legs. This club represents the maxillary palpus or "eye-collar," which nowhere in Macros has any such development. As has been previously noted, the pupa possesses a beak, placed between the eyes (for rupturing the cocoon). The mesoscutellum projects backwards, so that its sharp apex almost reaches the second abdominal segment. The eye-flange exists in other families, but is nowhere else so well-developed as here. It is a remarkable structure, forming, in this superfamily, a flat flange-like margin with sharp edge, separated from the antennæ, at the point where, in most pupæ, the eye abuts against the antenna. In some Eucleid pupæ it is marked with radiating lines that surround the eye, without quite joining the antenna. On the back of the abdominal segments there are transverse series of toothed spines, which vary in number and development in the different species. In dehiscence, the wings, maxillæ, etc., adhere together and do not break apart as do those of an obtect pupa. At the same time they are quite free from the abdominal segments.

The imagines present great differences in their general appearance, almost as much so as the larvæ. The white Eucleids of subtropical America, as represented by *Calybia slossoniae*, *C. immaculata*, *C. pygmaea*, *C. fumosa*, *C. jamaicensis*, *Leucophobetron argentiflua*, *L. argyrorrhoea*, etc., have been placed in the *Liparidae* by Kirby. The Tortricid appearance of our two European species led the early authors to place them among the TORTRICIDES. The brightly-coloured *Parasa media*, with its grass-green band, occupying the basal half of the wings, and its brush-like palpi, and the rounded (ovate) anterior forewings of *Scopelodes unicolor*, are sufficiently striking to attract attention. Yet there can be no doubt that the great differences in colour and wing-shape exhibited by the imagines of this superfamily are due to protective needs, and it is remarkable how fixed is the generalised form of the neuration, even in imagines so different in shape and general appearance. Griffiths says that the imaginal frenulum is very normal in the Cochliopodids, the spine being light and thin rather than powerful. The spinulæ of the female are few in number; in *Heterogenea cruciata* (*asella*), there are three, whilst in *Apoda avellana* (*limacodes*) there are about twice as many. The examination of four American species of this group, including the very singular species, *Phobetron pithecium*, shows an agreement with the British species in the development of this structure, although *Adoneta spinuloides* has it more fully developed than any other species examined. Bodine says that the antennæ present in some respects unusual conditions. Regarded as a whole, they are as generalised as any of the Frenatæ, but they possess cones which show a considerable degree of development. The base is almost entirely clothed with long, narrow scales, mingled with many shorter and broader ones, and in *Euclea querceti* every part of the surface is covered. The clavola, also, is closely covered, except on the ventral aspect, with broader scales, which, by their loose and irregular manner of insertion, indicate a very low degree of specialisation. In *Limacodes γ-inversa* even the ventral surface of the shaft bears numerous scales. In the pectinate forms the pectinations are heavily clothed, even to their distal ends, where the scales from three sides unite to form a thick tuft extending beyond the end. The pectinations are ventral, and at or near the distal edge of the segments. *Euclea querceti* is peculiar in having the pectinations of the cephalic side of the antennæ flattened, and nearly as broad as the length of the segments of which they form a part. In the Eucleids also there is an unexpected development of cones, which are long and slender, and are often many-pointed at the apex, as in the Megalopygids, some species having several to a segment. In the pectinate forms, the cones have migrated to the apices of the pectinations, where they are protected by the thick apical tuft already mentioned. Pits are very rare, seldom more than one or two to a segment, and then only on a few segments. The Eucleid antenna differs markedly from those of the Cossids and Psychids, but is very similar to that of the Megalopygids in the surface covering, in the character of the cones, and, where they occur, in the pits also. Chapman informs us that the Nepticulid antenna is entirely covered with scales. Our Cochlidids also, *Cochlidion avellana* and *Heterogenea asella*, have the antennæ similarly covered with scales, and the same character is noticeable in *Empretia stimulea.*

This superfamily has a wide distribution, but it belongs essentially to tropical and sub-tropical districts: The Philippines, Papua, Australia (including Tasmania), East Indies, China, Ceylon, India, Madagascar, South Africa, the Congo district, Sierra Leone, Central America, tropical South America, and Mexico produce many species. Species are found more sparingly in the Nearctic region (excluding western North America), the Palæarctic region (including Europe. Amurland, Corea, Japan and Askold). There are only two European species, both of which are found in Britain, although other species are found in the eastern portion of the Palæarctic area. A complete list of the species, and their geographical distribution, has been published by Kirby (*Synonymic Cat. of Lepidoptera Heterocera*, i., pp. 525-558). Of the two species that inhabit Britain, *Heterogenea cruciata* (*asella*) is most abundant in the New Forest, and is generally obtained by searching for the larvæ in the autumn. It is, however, most uncertain in its appearance. The males of *Cochlidion avellana* (*Apoda limacodes*) are often to be seen in the woods of our south and south-eastern counties in July, careering wildly over the tree-tops, and difficult to capture except with a long net. The female (and in dull weather the male) is frequently beaten from the bushes, when it drops like a lump of brownish clay to the ground, where it usually remains for a time motionless. The larva is to be beaten from oak-trees in September.

Family: COCHLIDIDÆ.

This family is here restricted to those species of this superfamily, which have the warts, spines, and setæ, found in the larvæ of the other families of this group, entirely absent in the last skin, although the primitive setæ appear to be retained in the first stage and peculiar spines are present in this and the three succeeding ones. This family certainly includes both the European species and, according to Dyar, certain American genera (*Packardia*, *Tortricidia*). It is totally impossible to give here a summary of the species under their proper subfamily groupings, as the life-histories of comparatively few have been worked out. The two genera that have representatives in Britain have, if Kirby's references of the species to this genus be correct, a remarkable distribution. According to this author we have the following :

Apoda, Haw.	
avellana, Linn.	Europe, Asia Minor
christophi, Graes.	Vladivostock
dentatus, Oberth.	Askold
codeti, Oberth.	Algeria
retractata, Walk.	Darjiling
apicalis, Walk.	Silhet
trigona, H.-Edw.	Arizona
tetraspilaris, Walk.	N. America
biguttata, Pack.	United States
y-inversa, Pack.	Pennsylvania
parallela, H.-Edw.	Florida
arenacea, Linn.	Cape Colony
albiguttatus, Snell.	Celebes
catenatus, Snell.	Celebes
nubeculosa, Snell.	Sumatra
dimidiatus, H.-Schäff.	Brazil
concolor, Walk.	Amazons
grisea, Hamps.	Nilgiris
inferna, Swinh.	Rangoon, Bhamo
? convergens, Walk.	Silhet
Heterogenea, Knoch	
cruciata, Knoch	Europe
uncula, Staud.	Vladivostok
nobilis, Staud.	Vladivostok
fulgens, Leech	Gensan, Ningpo
obliqua, Leech	Chang Yang
shurtleffi, Pack.	Brooklyn

Subfam. : COCHLIDINÆ.

Tribe : COCHLIDIDI.

Genus : COCHLIDION, Hübner.

SYNONYMY.—Genus : *Cochlidion*, Hb., "Tentamen" (1806). *Tortrix*, Linn., "Sys. Nat.," x., p. 531 (1758) ; Hb., "Eur. Schmett.," vii., figs. 164-5 (? 1803) ; *Bombyx*, Hufn., "Berl. Mag.," iii., p. 402 (1767) ; Fab., "Gen. Ins.," p. 279 (1777) ; "Mant. Ins.," p. 121 (1787) ; Esp., "Die Schmett.," iii., p. 140 (1784) ; Bork., "Sys. Besch.," iii., p. 447 (1790) ; Godart, "Lep. France," iv., p. 279 (1822). *Apoda*, Haw., "Lep. Brit.," p. 137 (1809) ; Kirby, "Cat. Lep. Het.," i., p. 552 (1892) ; "Handbook," etc., iii., p. 224 (1897) ; Meyr., "Handbook," etc., p. 451 (1895) ; Grote, "Sys. Lep. Hildesiæ," p. 3 (1895). *Chelonias*, Hb., "Verz.," pp. 397-8, in part (? 1822). *Limacode*, Latr., "Fam. Nat.," p. 474 (1825). *Limacodes*, Bdv., "Ind. Meth.," p. 57 (1829) ; Stephs., "Ill. Brit. Ent.," ii., p. 85 (1829) ; Bdv., "Hist. Nat. Lep.," i., p. 119 (1836) ; Wood, "Ind. Ent.," p. 28 (1839) ; Dup., "Cat. Meth.," p. 84 (1844) ; H.-Sch., "Sys. Bearb.," p. 15 (1845) ; Sta., "Man.," i., p. 169 (1857) ; Snell., "De Vlinders," etc., i., p. 120 (1867) ; Nolck., "Lep. Fauna Estl.," i., p. 118 (1868) ; Newm., "Brit. Moths," p. 21 (? 1869) ; Kirby, "Eur. Butts.," etc., p. 114 (1879) ; Frey, "Lep. der Schweiz," p. 89 (1880) ; Buckler, "Larvæ," etc., iii., pl. 53, fig. 8 (1889) ; Chapmn., "Trans. Ent. Soc. Lond.," 1894, p. 345 ; Barr., "Lep. Brit.," ii., p. 166 (1894). *Heterogenea*, Tr., "Die Schmett. Eur.," viii., p. 13 (1830) ; Speyer, "Geog. Verb. Schmett.," i., p. 304 (1858) ; Staud., "Cat.," p. 62 (1871) ; Peyer., "Cat. Lep. Als.," p. 57 (1880) ; Auriv., "Nord. Fjärilar," p. 58 (1888) ; Tutt, "British Moths," p. 349 (1896). *Cochliopoda*, Led., "Verh. des zool.-bot. Ver. Wien., ii., p. 114 (1852) ; Hering, "Stett. Ent. Zeit.," xlii., p. 153 (1881).

Hübner's *Tentamen* does not give a diagnosis of the generic title that we are informed should be adopted. The author simply notes : "*Cochlidia. Cochlidion testudo.*" The earliest characterised genus appears to be Haworth's *Apoda*.

The main characters of the genus are as follows :—

OVUM.—Oval in outline, flattened at base, slightly domed above, surface of shell reticulated.

LARVA.—Limaciform ; head retractile ; true legs ill-developed ; prolegs replaced by retractile suckers ; spined in early stages, smooth in last skin.

PUPA.—Incomplete ; appendages free ; abdominal segments free ; maxillary palpus well-developed ; strongly developed eye-flange ; beak between the eyes for rupturing cocoon.

IMAGO.—Head rough; ocelli present; tongue rudimentary; antennæ simple in ♂ and ♀, scaled all round shaft; labial palpi porrected, short and pointed, roughly scaled beneath terminal joint; thorax, abdomen and femora hairy; posterior tibiæ fully spurred; fore-wings rather oblong. Neuration generalised.

COCHLIDION AVELLANA, Linné.

SYNONYMY.—Species: *Avellana*, Linné, "Sys. Nat.," 10th ed., i., p. 531 (1758); "Fauna Suecica," p. 344 (1761); Werneburg, "Beiträge zur Schmett.," i., pp. 228-9 (1864); Kirby, "Cat. Lep. Heterocera," i., p. 552 (1892); "Handbook," etc., iii., p. 224 (1897). *Limacodes*, Hufn., "Berl. Mag.," iii., p. 402 (1767); Rott., "Naturf.," ix., p. 134 (1776); Esper, "Die Schmett.," iii., p. 140, pl. 26, figs. 3-9 (1784); De Vill., "Linn. Ent.," ii., p. 138 (1789); Staud., "Cat.," p. 62 (1871); Peyer., "Cat. Lep. Als.," p. 57 (1880); Auriv., "Nord. Fjärilar," p. 58 (1888); Meyrick, "Handbook," etc., p. 451 (1895); Tutt, "Brit. Moths," p. 349 (1896). *Sulphurea*, Fab., "Gen. Ins.," p. 279 (1777). *Bufo*, Fab., "Mant. Ins.," ii., p. 121 (1787). *Limax*, Bork., "Sys. Besch.," iii., p. 449 (1790). *Testudo*, Fab., "Mant.," ii., p. 121 (1787); Bork., "Sys. Besch.," etc., p. 447 (1790); Godt. et Dup., "Lép. France," iv., p. 279, pl. 28, figs. 1-2 (1822); Stephs., "Illus.," ii., p. 86 (1829); Bdv., "Ind. Meth.," p. 57 (1829); "Hist. Nat. Lép.," i., p. 119 (1836); Wood, "Ind. Ent.," p. 28 (1839); Dup., "Cat. Meth.," p. 85 (1844); H.-Sch., "Sys. Bearb.," ii., p. 16 (1845); Sta., "Man.," i., p. 169 (1857); Speyer, "Geog. Verb. Schmett.," i., p. 304 (1858); Snell., "De Vlinders," etc., p. 120 (1867); Nolck., "Lep. Fn. Estl.," i., p. 118 (1868); Newm., "Brit. Moths," p. 21 (? 1869); Frey, "Lep. der Schweiz," p. 89 (1880); Hering, "Stett. Ent. Zeit.," xlii., p. 153 (1881); Buckl., "Larvæ Brit. Lep.," iii., pl. 53, fig. 8 (1889); Chapman, "Trans. Ent. Soc. Lond.," 1894, p. 345. *Funalis*, Donov., "Brit. Ins.," iii., pl. 76 (1794). *Asella*, Esp., "Die Schmett.," iii., pl. 85, fig. 4, supp. p. 36 (1784). *Testudinana*, Hübn., "Eur. Schmett.," vii., figs. 164-165 (? 1803); "Verz.," p. 398 (? 1822); Ochs. et Treits., "Schmett. Eur.," viii., p. 14 (1830).

ORIGINAL DESCRIPTION.—*Phalaena Tortrix avellana*, alis superioribus testaceis; fasciis ferrugineis sesquitertiis (Linné, *Sys. Nat.*, 10th Ed., p. 531). Linné also refers to a previous description which reads as follows: "*Phalaena* seticornis spirilinguis; alis incumbentibus flavis; fasciis duabus griseis obliquis; postica interrupta. Magnitudine muscæ carnivoræ; alæ deflexo-incumbentes, breves, latæ; superiores pallide flavescentes, fasciis duabus retrorsum spectantibus, fusco-griseis, quarum postica in medio interrupta. Pedes spinosi" [Linné, *Faun. Suec.*, 1st Ed., pp. 272-273 (1746)]. This description is not accompanied by a specific name, it may belong to this species; Kirby has adopted it, following Werneburg.

IMAGO.—Male dark brown, female yellow-ochreous. Anterior wings with an oblique dark transverse line in the centre, and a second outside this, extending directly from the costa to the anal angle. Posterior wings brown, without markings, ochreous along the inner margin.

VARIATION.—The sexual dimorphism of this species is very marked. The males, as a rule, are smaller than the females, and of a deep red- or orange-brown colour. The females are of a yellow-ochreous tint. The individual specimens, however, exhibit considerable minor variation. The males are sometimes much suffused with black, the brown ground-colour showing only as scattered patches; others have a distinct blackish band stretching from the costa to the inner margin; the majority, however, have only the two normal oblique transverse lines, and a third curved line cutting off the anal angle; occasionally a male is found which possesses the ochreous colour usually indicative of the female. The brighter females are yellow-ochreous, approaching orange, and the hind-wings almost of the same colour as the fore-wings; others have the fore-wings somewhat greyer in tone, with the transverse lines strongly marked, and the hind-wings dark grey. A few specimens have the transverse lines almost obsolete, whilst others are very small, and are much below the average size of normal individuals of this species. The principal forms are:—

1.—Orange- or red-brown, much suffused with black, ♂ = *asella*, Esp., *Die Schmett.*, p. 36, "alis fuscis."

2.—Orange- or red-brown, with distinct, blackish, transverse band, ♂ = ab. *bufo*, Fab., *Mant.*, no. 118, p. 121, "fascia lata fusca."

3.—Orange- or red-brown with transverse lines, ♂ = *avellana*, Linn. This appears to be the male form corresponding with the female form described by Linné.

4.—Yellow-ochreous inclining to orange, with transverse lines and yellowish hind-wings, ♀ = ab. *sulphurea*, Fab., *Gen. Ins.*, "alis flavissimis: strigis duabus obliquis obscurioribus."

5.—Yellow-ochreous with distinct transverse lines and greyish hind-wings, ♀ = ab. *testudo*, Fab., "alis flavis, strigis duabus obliquis obscurioribus."

6.—Ochreous tending to testaceous, strongly marked transverse lines, grey hind-wings, ♀ = *avellana*, Linn.

7.—Two-thirds or less the size of normal specimens, in expanse of wing = ab. *minor*, n. ab.

8.—Dark brown, with two transverse lines and with yellow blotches (one on inner margin between the lines, and another on the outer line), ♂ = ab. *limax*, Bork.

Ovum.—The egg is 1·06 mm. in length, and ·75 mm. in width, flat, oval, colourless and transparent, with a lozenge-shaped reticulation covering the shell. The reticulation can be easily seen if examined in a suitable light, with a moderate magnifying power. The egg also lends itself readily to observation under a microscope, owing to its transparency, flatness, and the facility with which the moth can be induced to lay its eggs on glass. Burrows says that the eggs are laid naturally at the angles of the veins on the back of an oak-leaf. They are yellowish at first, then become grey, and hatch within ten days. Horton notes that a female lays more than two hundred eggs; he gives the egg as above one-twentieth of an inch in diameter, very large for the size of the moth, colour pale yellow, with an opaline appearance.

Habits of larva.—The larva rests on the upper surface of the leaves of its food-plant. The body is inflated so that a somewhat dome-like shape is produced, depressed slightly, however, at the sides. The larva is not, at first sight, much unlike some Lycænid butterfly caterpillars, and has a peculiar undulatory motion, due to the absence of prolegs, which has earned for the insects the name Cochliopodids ("slug-footed"). Poulton believes that, at first, larvæ of this kind walked by means of adhesive claspers, and that these gradually became shorter and broader, thus giving increased support by extending the area by means of which they adhered; gradually, he considers, the prolegs were lost, and the whole of the ventral surface took part in locomotion. As a matter of fact, the ventral surface is now covered with adhesive matter, and the larva leaves a silken band when it walks on glass; this band becomes white and opaque, and does not much resemble ordinary silk. Even when the larva is mature, and coiled up in its cocoon during the winter, previous to pupation, the ventral surface is covered with an adhesive material, so that, on touching this surface with a knife or other smooth object, the larva may be raised from the cocoon, the adhesive matter being quite sufficient to bear the weight of the larva. The suckers, which replace the abdominal prolegs, also aid greatly in progression.

Larva.—The *newly-hatched* larva is spiny, somewhat elongated, and not *Chiton*-shaped (Burrows); whitish, stout, with a small black head (Horton). Chapman says that in it the ordinary tubercles can be made out as very faint dots, and, in addition, there are a number of evaginated, spurred spines, three on each side of the thoracic, and two on the abdominal, segments, the latter arranged as a dorsal and lateral series on either side. The dorsal series is placed alternately on the segments . · . · . · ., outer on the first abdominal, inner on the second, and so on; this arrangement has suggested to Chapman that they are homologous with alternate members of the double dorsal series of structures present in the larva of *Micropteryx* (*ante*, p. 138). After the *first* moult the spines become smooth and straight. The larva is now 1·4 mm. in length, and carries its cast skin, with some frass, on the terminal spines (? like Adscitid larvæ). The two dorsal rows of spines are now double, *i.e.*, the alternate members, absent in the first skin, are now developed, each spine consisting of a pointed hair-like process, but with an internal tubular structure that differentiates it from a real hair, although the terminal portion may be homologous with the hairs carried by ordinary tubercles. On the mesothorax the spines are more equally distributed; on the metathorax they are a little larger than on those following, but have the same distribution. This is such that the back of the larva forms a hollow groove, bounded on each segment by a double tubercular spine rising on either side, which are alternately (on consecutive segments), rather nearer and further from the middle line, those on the 3rd and 5th abdominals being notably further out. On these (3 and 5 abdls.) the outer spines are very large and project more laterally. This double tubercle consists really of an inner and outer process, each bearing a spine, the inner one being rather the larger. The spines are without any evident processes or hairs, but their terminal third (or fourth) is dark in colour, and apparently articulated to the basal portion, which is pale and nearly colourless, except for the articulation of the terminal portion, which looks brittle. The whole spine looks very like a nettle sting, and seems to be tubular. On the outer margin of these tubercles are several very minute spinules or hairs, as well as some thicker and apparently capitate ones in the lateral region. The true legs are minute, and the spinneret quite distinct. After the *second* moult, the larva is 3 mm. long and 2 mm. wide. The arrangement of the spines is much as in the previous skin, but small spinules now surround the bases of the others, and whilst the spines proper are simple, the spinules have coroneted apices. The dorsal humps are large, and consist of an inner and outer spine, which are simple, but on the tubercular structures at their inner and outer bases the points that stud the general surface are more crowded. The lateral humps are single, but have a more complex structure. The pyramidal base looks three-jointed, and carries subsidiary transparent spines with divided points, like those on spines of the newly-hatched larva, but a little less elaborate. Some appear to belong to each joint. The terminal spine has a jointed apex, like the dorsal ones, and the basal portion looks as if articulated to the tubercles, but this is possibly a deceptive appearance. In the incisions at the bottom of the dorsal and lateral grooves are yellow islets, probably belonging to the anterior segment, but apparently belonging to neither. The humps and subcutaneous space look quite glassy, the interior is green, with yellow lines beneath the dorsal humps, with extensions inwards, giving, by various refractions, very curious and marvellously beautiful effects. The dorsal view is an ovoid, with a border of fifteen points on each side, very regularly spaced; of these, the anterior and two posterior belong to the dorsal series; two, three, four and five belonging to the meso- and metathoracic segments; the ninth and tenth abdominals are without the lateral humps. After the *third* moult, the arrangement of the spines is as before, but the spinules are less distinctly developed, and the skin-surface now becomes covered with minute spikelets. In the third and fourth skins there also appear to be some glandular structures, which have a dorsal and dorso-lateral position on each segment. With the *fourth* moult the spines disappear. The spinneret of this larva is remarkable until the penultimate stage. It is not a pointed organ, but is flattened out like the tail of a fish, and the silk that the larva spins upon which to walk is not spun in the form of a thread, but as a very long ribbon (Chapman). The *adult* larva is of a bright pea-green colour, the ventral surface closely appressed to the surface on which it rests, the head retractile within the prothorax, and the thoracic segments retractile within the 1st abdominal segment. When retracted the head and thoracic segments are quite ventral, the abdominal segments forming an oval dome. The abdomen, viewed from above, is divided into three slightly concave areas, the dorsal, bounded on each side by a raised, wavy, primrose-yellow, subdorsal ridge, and two lateral, each bounded above by one of the subdorsal ridges, and below by a similar yellow subspiracular ridge, which is in contact with the object on which the larva is resting. The two, wavy, subdorsal ridges are ornamented with crimson ("violet," Fenn) points, placed one on either side of each segmental incision, and these ridges are continued in front round the anterior edge of the 1st abdominal segment, thus enclosing the dorsal area in this direction. This continuation is yellow edged with crimson. The subspiracular ridges also unite with the dorsal ridges anteriorly on the 1st abdominal segment, and posteriorly on the anal segment. The anal flap extends slightly beyond the ventral area of the body. The segmental incisions form, dorsally, conspicuous curved lines of a yellowish tint. The ventral area is glaucous green. The head is smooth, shiny, pale green, with brown mouth-parts, shiny, black ocelli, and bears a few pale hairs. The thoracic segments are green, and on the venter of the prothorax, placed laterally, is a comparatively large flesh-coloured circle, enclosing a raised, cream-coloured, bluntly conical centre (and having the appearance of painted wood). This is, perhaps, the prothoracic spiracle. The 1st abdominal segment is of a bright orange colour edged with crimson anteriorly. The skin of the abdominal segments dorsally is composed of a large number of transparent warts, the transparency being best seen where they form the lateral margins of the body. The ventral edge of the body (lower than the subspiracular ridge) is white when appressed to a glass slide, and closely resembles in this respect the white suckers on the first eight abdominal segments. Of these, the suckers on segments 4-7 are much the better developed. These suckers are very complex, and occupy on these segments exactly the same position as ordinary prolegs, with which, indeed, they appear to be homologous. The abdominal spiracles are of a similar large, open, circular shape as the structure we have supposed to be the prothoracic spiracle, but the rim is only of a darker shade of green than the ground colour, and the central area is greenish-yellow. They are placed somewhat more than halfway up the lateral area of the larva. There is a single, pale, subspiracular hair on each segment, and one longer hair on either side of the dorsum of the anal flap; several others are to be found on the posterior portion of the anal segment. Chapman has also noted that these hairs are present in the 2nd, 3rd and 4th skins, and we draw special attention thereto, as Dyar suggests (*ante*, p. 364) the general absence of subspiracular tubercles, which these undoubtedly represent. The true legs are well-developed, transparent, green in colour, with a pale brown hook. [Described from Westerham larva, October, 1897.]

Larval spines.—The development of the spines of this larva is very remarkable. At the time that the larva has completed its growth in the eggshell, it is without any spines or processes, but at the period of hatching certain long spines, of which there are at least four on each abdominal segment, are rapidly developed, and are arranged as a dorsal and lateral series on either side. The ordinary tubercles can be detected as faint dots, but these spines are quite independent of the ordinary tubercles, and differently placed. Chapman says that the dorsal series on one side, although consisting of one spine only on each segment, has them placed as though they were the double rows of *Eriocephala* (*i.e.*, *Micropteryx*, *ante*, p. 138), with alternate spines omitted, *i.e.*, the inner spine is wanting on the 1st abdominal segment, the outer one on the second, and so on, alternately. Dyar considers the alternation as a sign of weak and strong segments). Laterally, the spines appear to belong to the lower row of the lateral series of *Eriocephala* (*Micropteryx*), but the upper row is represented on the thorax by two spines. With regard to the growth of these spines, a circular mark is seen in the unhatched larva, on the site of each spine, and is the summit of a cylindrical body deeply embedded in the larval substance. This body is, in fact, the spine, of which the upper third appears to be already stiff and solid, with its apex on the surface ready to emerge, whilst the lower two-thirds form a soft invaginated sheath surrounding the upper part. When half of the soft portion of the spine has emerged, there appears upon it a spur, and, when the emergence is completed, a distinct joint is visible at the base of the upper portion. The soft portion appears very rapidly to become hard. These spines are about equal in length to the diameter of the larva, and are divisible into three portions: (1) The basal, rather thick and smooth, and terminating at the lateral spur. (2) The middle portion, continuous with the basal and structurally the same—only narrower—and quite smooth. (3) The terminal portion, separated from the middle portion by a joint, or transverse line of union, with a series of minute points or teeth, apparently arranged in a somewhat spiral manner along its shaft, and terminating at the apex in a slight enlargement, and a coronet of angular points, six to nine in number. The lateral points are difficult to see except when taken in profile, but are rather numerous and laterally arranged. The inner structure of these spines has all the appearance of consisting of a separate included tube running its whole length, and having a branch to the lateral spur. After the first moult, these spines are replaced by straight spines, with a smooth outline, and tapering continuously from base to apex. They have, however, a joint about three-fifths of the length from the base to the apex, looking harder, browner, and more solid, and they seem to have a central tube. They appear to originate from deep tissues, and the skin looks like a thick coating of glass, through which they come. In this skin, however, the dorsal set of spines is now double, *i.e.*, the double row, of which the alternate members are wanting in the first larval stage, is now complete, and they remain so even in the adult larva, though they are now merely prominences, and not spines. In the second and third skins, there are, especially in the thoracic region, round the bases of these spines, very minute spinules, apparently of a structure very similar to the last joint of the spinules in the first stage. [Besides this excellent description, Chapman gives first-class figures of the newly-hatched larva, spines, etc., in the *Trans. Ent. Soc. London*, 1894, Pl. vii., figs. 14-20.]

Larva just previous to pupation.—When coiled up in its cocoon, the larva is a curious object. The dorsum is green, with no darker markings whatever; there is a distinct dorsal depression, whilst the sides appear now as subdorsal depressions, owing to the bulging out of the ventral area. The lateral margins and anal area orange-yellow. The thoracic segments not grooved dorsally or laterally. The skin, under a two-thirds lens, now appears finely warted and much wrinkled transversely. The eight abdominal spiracles are very tiny, pinkish in colour, with a pale yellowish-white rim, the pair on the 6th abdominal segment much larger than the others. The conspicuous external structures surrounding them, and so prominent in the adult larvæ, have entirely disappeared, leaving the spiracles themselves distinctly visible. The prothorax is only visible ventrally, and the head is withdrawn into it, showing the almost transparent face in its centre; whilst the prothoracic spiracles show conspicuously on each side. The venter is very transparent, its surface covered with an adhesive substance, and the internal structures visible within.

Cocoon.—The cocoon consists of a thin outer pellicle of flossy silk, which is interwoven with the surrounding moss (in the examples under observation). Within this is a closely woven, oval structure, reddish-brown in colour, of a somewhat papery texture, but tough for its thickness. It is provided with an easily separated lid. The cocoon is covered inside with a delicate silken lining, which may be separated from the part surrounding it, and the larva is so coiled up in it as to occupy most of the available space. Fletcher observes that the cocoon becomes flattened on each side when attached to others on a leaf, and when spun upon an oak-leaf, fits so closely to it, as to take the impression of the smallest veins. The larva lies unchanged in the cocoon all the winter, becoming a pupa in May or June. The pupal stage lasts only about fifteen days, and the pupa escapes from the cocoon before the emergence of the imago. Borkhausen says that he found the cocoons of the ab. *limax* under the fallen leaves in a beech wood.

Pupa.—The pupa is described by Fletcher as being short, thick and stumpy; broadest about the middle of the abdomen; thorax large, rounded, extended in front above the head; wing-cases long, well-marked, with the neuration plainly traceable; leg-cases almost free, those of the third pair extending beyond the wing-cases to the anal extremity; creamy-white in colour, with head and thorax tinged with brown; eyes visibly blackish; on the dorsal surface of abdominal segments 2 to 8, is a broad, transverse, yellowish band; the whole surface roughened with minute spines pointing backwards, these spines being yellow at the base, dark brown at the tip. Chapman says that the pupa is, in structure, of the Micro type. It is very round and squat, and superficially resembles the pupæ of *Lasiocampa quercûs*, *Eriogaster lanestris*, *Cerura vinula*, and similar pupæ, whose larvæ make a cocoon of the same character as does *Cochlidion avellana* (*testudo*). It has the wing- and appendage-cases not attached to the abdominal segments. In colour, the pupa is pale brown or fawn, with wings so transparent as to be hardly visible. The mouth-parts are large and elaborate. The maxillæ are small and short, but are prolonged outwards, and, after passing through a narrow neck, terminate in a well-developed club, between the eyes, antennæ and legs. This club represents the maxillary palpus (eye-collar), which, nowhere in Macros, has any such development. It appears to possess a second member (= laciniæ?). The abdominal segments 1-6, ♀, and 1-7, ♂ are free (*i.e.*, not soldered to the wings and appendages), and appear to be capable of independent movement on each other. The appendages, though fused together, are fused so slightly as to be easily separated without injury. In the empty pupa-case, all the segments and appendages are freely separable. The pupa possesses a beak (for rupturing the cocoon) between the eyes; the mesoscutellum projects backwards from the mesothorax, so that it covers the middle of the metathorax, whilst its sharp apex reaches to the middle of the 1st abdominal segment. The pupa also possesses what Chapman has described as the "eye-flange." Where, in most pupæ, the eye abuts against an antenna, it is, in this species, rather separate, and a flat flange-like margin with sharp edge and marked with radiating lines, surrounds the eye without quite joining the antenna. On the sides of the metathorax and first abdominal segment there are curious brown ribs and wrinkles. The abdominal segments 2-10 have an area across the front of the dorsum of each segment covered with minute spines (not a single row, as is so usual). The spiracles of the 2nd and 3rd abdominal segments are covered by, but visible through, the hind-wings. The pupal wings reach to the end of the 7th abdominal segment, and the tarsi to the 8th. Borkhausen compares the pupa (which he calls a "Pupa incomplete") with the pupæ of some beetles, "all the extremities being separated from the body, and the skin soft and yellow."

Dehiscence.—The head, maxillæ, maxillary palpi and antennæ free from thorax and abdomen; the eye-covers also free; in fact, all the appendages, wings, etc., become "free," but do not separate, *i.e.*, the covers are complete and adhere together, as do those of a dragonfly, but do not in any way break apart, as do those of an obtect pupa (Chapman).

Food-plants.—Nut, pear (Linné); oak, beech (Borkhausen); birch (Buckell); whitethorn and blackthorn (Holland); sycamore (Kaltenbach); *Arbutus unedo* (Cuní y Martorell).

Parasites.—*Sphinctus serotinus*, at end of September, and *Pelecystoma lutea*, Nees, bred in the middle of July, 1887, by W. H. B. Fletcher (Bridgman).

Habits and habitat.—This species inhabits woods in the southern and western parts of the British Islands. The male flies rapidly in the hot sunshine, usually high up (often too high to reach) over the trees and underwood. Bower has, however, found it flying at "sunset," both at Lyndhurst and Chattenden. The female is usually sluggish, and drops like a small lump of clay to the ground from the trees or bushes in which it hides, when one is beating, but Bower has seen the female flying in the afternoon. Horton obtained the species by kicking against the stems of young oaks, in a part free from underwood, and watched the moths half falling and half flying as they were disturbed from the tree-tops; and James has beaten the imago from hazel. Jones, Fenn, and others, have found the insects *in cop.* during the day, on grass culms. Bloomfield has caught the species by "dusking," and Burrows on sugared trees (not at the sugar) as late as 11 p.m. Dillon also captured three specimens (2 ♀ and 1 ♂) flying at dusk, at Clonbrock, and Lowe took specimens at Aigle, at light. Holland has made satisfactory use of a beating-tray for their capture, as many as seven specimens (of both sexes) having fallen victims on June 21st, 1891, at Aldermaston, to this mode of capture.

TIME OF APPEARANCE.—The imagines appear during June and July, from larvæ that feed up the preceding August-October, and lie in their cocoons all winter and pupate in May. Burrows gives September 14th-October 9th, 1897, for full-fed larvæ at Ipswich; Cross notes September 9th, 13th, 20th, 1897, from oak, and October 8th, 1897, from beech, in the New Forest; October 6th, 1860, from oak, at Lower Wick (Horton), Sept. 4th, 1897, at Westerham (Turner), etc. Imagines have been recorded as occurring on July 1st, 1857, at Faversham (Stowell), July 7th, 1856, at Shooter's Hill Woods (Crewe), June 7th, 1857, at West Wickham (Healy), June 27th, 1858, August 5th 1860, at Darenth, June 12th, 1865, at Blean Woods, and July 14th, 1878, at Chattenden (A. H. Jones), June 26th, 1859, at Worcester (Edmunds), June 23rd, 1860, June 16th, 22nd, 1862, June 7th, 1865, at Darenth, June 11th, 1865, at Blean Woods, June 21st, 1875, at Sidcup, June 20th, 1885, June 30th, 1886, June 17th, 1893, at Chattenden, and bred eight from June 13th-27th, 1893, from Chattenden (Fenn), several beaten June, 1860, at Darenth (Rye), July 5th, 1863, *in cop.*, at Lower Wick (Horton), June 10th, 1865, at West Wickham (Cole), June 27th, 1863, July 12th, 1869, at Guestling, by dusking (Bloomfield), 1st week of August, 1877, in New Forest (Porritt), June 20th-July 4th, 1875, at Lyndhurst, June 18th, 1883, June 30th, 1893, at Chattenden (Bower), July 9th, 1876, at Trench Woods (Blatch), June 9th, 1876, at Heckfield, June 21st, 1891, at Aldermaston, June 20th, 1892, at Padworth, June 7th, 1893, in Pamber Forest, June 18th, 1893, at Burghfield (Holland), July 9th, 1881, at Chattenden, June 22nd, 1883, nr. Ipswich (Mera), July 10th, 1891, July 8th, 1892, at Romsey (Kaye), June 12th 1891, at Abbott's Wood (W. E. Nicholson), June 22nd, 1892, May 31st, 1893, at Emsworth (Christy), June 7th, 14th, 1894, at Hailsham, beaten from hazel (James), June 14th, 1895, *in cop.*, at Ipswich (Baylis), June 12th, 1894, at Abbott's Wood (Lowe), July 1st-4th, 1895, several in New Forest (Bayne), June 10th, 1895, June 10th, 1896, at Bentley Woods, nr. Ipswich (Morley), June 27th, 1897, at Tilgate (Sheldon), June 28th-July 16th, 1897, nr. Ipswich, two on sugared trees at 11 p.m. (Burrows), August 1st, 1897, at Hazeleigh Wood, worn, June 28th, 1898 (Raynor), middle of June, 1869, on Parnassus, and May 23rd, 1869, in I. of Naxos, Greece (Staudinger), June 10th-17th, at Sologne (Sand).

Localities.—Berks: Tilehurst, Aldermaston, Reading, Burghfield and Padworth (Holland). Essex: nr. Southend (Whittle), Colchester (Harwood), Hazeleigh Wood (Raynor), Eastwood, males sometimes common (Vaughan). Galway: Clonbrock (Dillon). Gloucester: Highnam (Merrin). Hants: Denny Wood (Lockyer), Brockenhurst (Lane), Romsey (Kaye), Lyndhurst (Bower), Pamber, Heckfield (Holland), New Forest (Porritt), Emsworth (Christy), Woolmer Forest (Barrett). Kent: Birch Wood, Chislehurst, Darenth and Sydenham (Stephens), Sidcup (Fenn), Shooter's Hill Woods (Crewe), Faversham (Stowell), Wigmore Wood (Chaney), Westerham (Warne), West Wickham (Healy), woods around Rochester (Tutt), Chattenden and Blean Woods (A. H. Jones). Oxfordshire. Rutland: on the borders of Rutland and Leicester (Dixon). Suffolk: Beccles (Crowfoot), Belstead (Lingwood), Bentley (Miller), Bentley Woods, nr. Ipswich (Morley), Euston (Williams), Ipswich (Burrows), Playford (Greene). Surrey: Shirley (Gregory). Sussex: Tilgate (Sheldon), Goring Woods (Fletcher), Hayward's Heath, Plaskett Wood and Battle (Jenner), Guestling (Bloomfield), Hailsham (James), Abbott's Wood (Porritt), Brighton and Worthing (Stainton). Worcestershire: Trench Woods (Blatch), Lower Wick (Horton), Worcester (Edmunds). Yorkshire (?): York, larva, September, 1876, from birch (Wilson).

Distribution.—Asia Minor: Bithynia, Pontus (Staudinger), the Taurus (Röber). Belgium: (Fologne). Denmark: sparingly (Aurivillius). France: Corsica (Speyer), Nice (Curò), Alpes Maritimes (Millière), nr. Paris, Depts. of Maas, Meurthe, Doubs, Puy-de-Dôme, Savoy (Speyer), hills of Provence (Constant), Motte-Feuilly, forest of Châteauroux, Sologne, St. Florent, Enval, Volvic (Sand). Germany: Pomerania, Vogelsang, Messenthin, Grambow, Julow, Hökendorf, Stepenitz, etc. (Hering), Thuringia, Gotha, Siebleber Holz., Berlach, Lauchaer Holz., etc. (Knapp), Mangfall (Gumppenburg), Berlin, Krefeld (Speyer), Strasburg, Kastenwald, Tannenwald, Hardt, Nonnenbruch, Langen Erlen (Peyerimhoff). Greece: Parnassus, Corfu, Naxos, (Staudinger). Italy: Piedmont, Lombardy, Venetian Provinces, rather common, Liguria (Speyer), moderately common throughout—Tuscany, Naples, Sicily, Sardinia etc. (Curò). Netherlands: most of the provinces (Snellen). Russia: Schleck, Groesen, Rambdau, Pichtendahl (Nolcken), Livonia (Lienig and Speyer), Volga district, about Kasan (Speyer), Transcaucasia-Borjom (Romanoff). Scandinavia: Gottenburg, Œland, Lapland (Speyer), S. Sweden to E. and W. Gottland absent in Norway and Finland (Reuter). Spain: Barcelona dist. in mts., Verano (Cuní y Martorell), Province of Teruel (Zapater and Korb). Switzerland: Basle (Peyerimhoff and Frey), Zürich (Frey), Winterthur (Biedermann), St. Gallen (Täschler), Aargau (Wullschlegel), Bremgarten (Boll), Bechburg (Stehlin), Berne (Rätzer), nr. Schüpfen (Rothenbach), Chur (Calflisch), Aigle (Lowe), on the Lägern, Zürichberg, and the Uto (Rühl).

HETEROGENEA, Knoch.

Synonymy.—*Heterogenea*, Knoch, "Beiträge Ins.," iii., p. 60 (1783); Stephs., "Ill. Brit. Ent.," ii., p. 84 (1829); Ochs. and Treits., "Schmett. Eur.," viii., p. 13 (1830); Boheman, "Entom. Ant.," p. 128 (1851); Sta. "Man.," i., p. 168 (1857); Staud., "Cat.," p. 62 (1871); Auriv., "Nord. Fjärilar," p. 58 (1888); Kirby, "Cat. Lep. Het.," p. 556 (1892); "Handbook," etc., iii., p. 226 (1897); Meyr., "Handbook," etc., p. 450 (1895); Tutt, "Brit. Moths," p. 349 (1896). *Bombyx*, Fab., "Mant. Ins.," ii., p. 121 (1787); Vill., "Entom. Linn.," 449 (1789); Bork., "Syst. Beschr.," p. 450 (1790); Godt., "Lépid. France," iv., p. 282, pl. 228, fig. 3 (1822). *Tortrix*, Hübner, "Eur. Schmett.," vii., figs. 166, 167 (? 1803). *Chelonias*, Hb., "Verz.," p. 398, in part (? 1822). *Heterogenia*, Wood, "Ind. Ent.," p. 28 (1839). *Limacode*, Ltr., "Fam. Nat.," p. 474 (1825). *Limacodes*, Bdv., "Ind. Meth.," p. 57, in part

(1829); Dup., "Cat. Lep.," p. 84, in part (1844); Newm., "Brit. Moths," p. 21 (? 1869); Nolck., "Lep. Fn. Estl.," p. 118 (1868); Frey, "Lep. der Schweiz," p. 90 (1880). *Cochliopoda*, Hering, "Stett. Ent. Zeit.," ii., p. 153 (1881).

There is no absolute diagnosis by Knoch of *Heterogenea*. It is practically included in his account of the species, which extends to 18 pages. He explains that the insect will not conform to any of Linné's groups, and adds:

> Both larva and pupa are entirely different from any previously described moths [the "shield-larvæ" of certain butterflies differing little from other larvæ except in shape] and being of entirely different structure, cannot be included in any of Linné's sections of *Phalaena*. The imago differs in the outline of the wings from the Tortricids, but has filiform antennæ like most of them, and is therefore in some measure intermediate. The antennæ do not, however, afford a reliable character for their classification, so that, I consider, this and the allied one (*Phalaena limacodes*) must form a new section. For this reason I have called them "heterogeneous" Phalaenae.

Chapman's observations on the structure of the evaginated spines of the larva of *Heterogenea* suggest this as being probably a more generalised genus than *Cochlidion*.

The principal characters of the genus may be diagnosed as follows:—

Ovum.—Flat, ovoid, slightly narrowed at one end, transparent, surface reticulated.

Larva.—Limaciform; head retractile; true legs illdeveloped; prolegs replaced by retractile suckers; very finely spined in early stages, smooth when adult.

Pupa.—Incomplete; appendages free; abdominal segments free; maxillary palpus remarkably well-developed; well-developed eye-flange; beak for rupturing cocoon.

Imago.—Head hairy (not rough); ocelli present; tongue rudimentary; antennæ simple in both sexes, scaled all round shaft. Labial palpi ascending; thorax, abdomen and femora not hairy; posterior tibiæ with middle spurs absent; fore-wings somewhat triangular in shape. Neuration generalised (but differing from that of *C. avellana*).

HETEROGENEA CRUCIATA, Knoch.

Synonymy.—Species: *Cruciata*, Knoch, "Beitr. Ins.," iii., p. 60, pl. 3, figs. 1-10 (1783); Kirby, "Cat. Lep. Het.," i., p. 559 (1892); "Handbook," etc., p. 226 (1897). *Asella (us)*, Schiff., "Sys. Verz.," p. 65 (1776, Cat. name); Fab., "Mant., Ins.," ii., p. 121 (1787); Bork., "Sys. Besch.," iii., p. 450 (1790); Godt. et Dup., iv., "Lép. France," p. 282 (1822); Bdv., "Ind. Meth.," p. 57 (1829); Stphs., "Illus.," ii., p. 85 (1829); Wood, "Ind. Ent.," p. 28 (1839); Dup., "Cat. Meth.," p. 84 (1844); H.-Sch., "Sys. Bearb.," ii., p. 16 (1845); Boh., "Ent. Ant.," p. 128 (1851); Sta., "Man.," i., p. 168 (1857); Speyer, "Geog. Verb. Schmett.," i., p. 304 (1858); Nolck., "Lep. Fauna Estl.," p. 118 (1868); Staud. and Wocke, "Cat.," p. 62 (1871); Newm., "Brit. Moths," p. 21 (? 1869); Frey, "Lep. der Schweiz," p. 90 (1880); Hering, "Stett. Ent. Zeit.," xlii., p. 153 (1881); Auriv., "Nord. Fjärilar," p. 58 (1888); Buckler, "Larvæ," etc., iii., p. 73 (1889); Meyrick, "Handbook," etc., p. 451 (1895); Tutt, "British Moths," p. 348 (1896). *Asellana*, Hüb., "Eur. Schmett.," vii., figs. 166-167 (? 1803); "Verz.," p. 398 (? 1822); Ochs. et Treits., "Schmett. Eur.," viii., p. 18 (1830).

Original description. — *Phalaena Heterogenea cruciata*, elinguis, alis deflexis nigro-fuscis, fimbria præter apicem dilutioribus. *Larva* ovata, hexapoda. Caput absconditum flavum. Corpus viridescens, cruce sanguineo, macularum flavescentium ordinibus directis in interstitius 5 in segmentis 6 in dorso perforatum. *Pupa* incompleta, fusca, in folliculo quiescens, continet singulas insecti partes tenui membrana inclusas. *Phalaena* unicolor nigro-fusca, femina interdum fusca. Oculi nigri. Antennæ filiformes. Alæ tortriciformes. Tibiæ flavescentes (Knoch, *Beiträge Ins.*, etc., iii., p. 60). Knoch's Pl. 3, figs. 1-10, undoubtedly represent the transformations of the insect usually called *Heterogenea asella*.

Imago.—Anterior wings triangular in shape; shining unicolorous dark brown in the male, yellow-brown in the female. Posterior wings blackish.

Variation.—Considerable sexual dimorphism is exhibited by this species, the males being, usually, much smaller and darker than the females, the fore-wings of the former varying from a colour which is distinct purplish-black, through blackish-fuscous, to brownish-fuscous; the palest specimens of this latter form are slightly tinged with ochreous, and exhibit faint traces of a transverse oblique line rather nearer the base than the centre of the wing, and an oblique shade (rather than line) marking off the apical area. The darkest females are brownish-fuscous, the paler forms vary through a dull (red-) brown and yellowish-brown to a quite pale yellow colour. The principal forms met with are:—

1.—Blackish with purple tinge, ♂ = *nigra*, n. ab.

2.—Blackish-fuscous, ♂ = *cruciata*, Knoch, "alis nigro-fuscis" = *asella*, Fab.

3.—Brownish-fuscous, somewhat mottled with dark ochreous, ♂ and ♀ = ab. *typica*, n. ab., much the commonest form of the species in England.

4.—Dull brown inclining to red-brown, ♀ = ab. *intermedia*, n. ab.

5.—Ochreous-yellow, ♀ = ab. *flavescens*, n. ab.

Ovum.—The mode of oviposition of this species was described by Standish, who observed that some sarsenet with which he had confined a female moth was bespattered with a whitish and glutinous-looking substance, resembling gum or varnish. He concluded that the substance was composed of eggs, although he could not detect an egg of any shape. Buckler described eggs laid on the side of a chip box, on July 13th, 1877, as being agglomerated together, and being "somewhat of a drop shape," but ill-defined, from their being connected together in little lumps; the colour, very pale, shining, transparent and gelatinous-looking, otherwise much the colour of the chip; by the end of the month they began to grow yellowish, and then to be tinged with the colour of brown sherry in parts of the little batches; after this, they began to hatch. Chapman states that the egg of this species, like that of the last, is flat, ovoid, somewhat narrowed towards one end, colourless, very transparent, with lozenge-shaped network of cell-structure of the cell. The longest diameter is less than ·5 mm.

Habits of larva.—The larva feeds on the edge of beech leaves, and when eating the head is withdrawn into the prothorax, which also covers that portion of the edge of the leaf that is being devoured. Probably the most peculiar point about it, is its mode of progression. Buckler says that the six true legs are distinctly to be seen when the larva is in motion, but no ventral or anal prolegs are perceptible, and, instead of them, it has, along the margin of the venter, which is deeply depressed centrally, a soft projecting ridge of extremely flexible skin. This serves very well the purpose of legs, owing to its undulatory movement from behind forwards; one wave at a time being formed under each segment, and slowly advancing and subsiding in regular succession as far forwards as the first abdominal segment. The larvæ attach themselves so closely to the food-plant that it is almost impossible to beat them. They must be searched for in October on the beeches.

Larva.—The *newly-hatched* larva, according to Buckler, is a mere speck, of a rounded ovate figure, dark brown above and pale greenish beneath, in short, a miniature representation, apparently, in all respects, of the mature larva. The same observer describes the *full-grown* larva, when fully-stretched out, as about half-an-inch long, and a quarter of an inch across the middle of the body, whence it tapers towards each end, but, in repose, its length does not exceed three-eighths of an inch, as the head and prothorax are then entirely retracted, so that the front part of the body appears but little tapered. The head is very small, and rather flattened (as in the larvæ of the *Lycaenidae*). The anal extremity is rounded, and, viewed sideways, the back appears somewhat arched, and the ventral surface is in close contact with the leaf on which it rests. The segments are only marked by narrow dimpled depressions. There are also minute circular dimples on the back, one in the centre of the front of each segment, and two at the back in the subdorsal region. This region, being a little raised on each side, forms a slight dorsal hollow. The head is smooth and shining, the back and sides rather so, though the skin there is covered with pubescence, which is, however, so fine as to be seen only with a powerful lens. It is noticeable that the dimpled spots were for the most part paler than the rest, and that a few short and very minute bristles are scattered at each extremity, and at intervals along the back. The ground-colour is of a pale yellowish-green, watery-looking along the sides, fading into somewhat of a pale flesh tint beneath. On the back, beginning at the front of the mesothorax, is a broad olive-brown mark, reminding one of the dark saddle on the larva of *Cerura vinula*. This mark lessens a little in breadth on the 1st abdominal segment, and then grows broader on the following one, attaining its greatest breadth on the 3rd and 4th abdominal segments, where it reaches low down on the sides. It begins to decrease again on the 5th abdominal, and gradually narrows to the anal tip. The olive-brown tint is darkest on the meso- and metathorax, and there is throughout an outline of darker brown. This is further relieved below by a pale, sulphur-yellow border, which enlarges to a spot on the side of the 1st abdominal segment, with smaller spots on the metathorax and 2nd abdominal. The prothorax is pale yellowish-green. The head is also yellowish-green, with a slight tinge of brown, the mouth edged above and on each side with dark brown. The papillæ are yellowish-green. The dorsal vessel, dark brown in colour, can be seen through the olive colour on the back as far as the end of the 6th abdominal segment. The ventral surface is almost colourless, with a clear, pellucid, jelly-like appearance. Fenn gives the measurements of the adult larva as half an inch long by one quarter broad. He describes it as onisciform, slightly tapering behind, and says that the dorsal surface is raised into a ridge, with the sides slightly indented, and the under surface much flattened. The dark dorsal mark is described as a large diamond-shaped red marking, the lateral angles of which reach to the spiracles, and are prolonged in front as a broad, red-brown band towards the head, these dorsal markings combining to form a spear-head mark with the apex or point behind, the edges being darker red.

Larval spines.—The newly-hatched larva appears to be very similar to that of *C. avellana* (*testudo*). The spines appear to be in precisely the same position as in that species, *i.e.*, a double dorsal row with the alternate members absent, and a lateral series, with a more complicated arrangement on the thoracic segments. Possessing a series of specimens showing the different stages in the process of extrusion, it is equally clear, in fact quite certain, that the spines before hatching are invaginated into the interior of the larva, precisely as in *C. avellana*, and are extruded and assume their exterior position shortly after the larva leaves the eggshell, in the manner thus described in the case of the latter species. There is, however, a very important difference in the structure of the dorsal spines, *viz.*, each one has two branches instead of being simple. As it evaginates at first a simple straight portion protrudes, but is seen to enclose not one but two terminal portions, the portions that from the first appear to be stiff and hardened; then the soft evaginating portion divides into an anterior and posterior horn, separating from each other at an angle of 80°-90°, and the hard terminal portions, at first parallel to each other, cross one another at an angle, and finally form the extremities of these two branches. There is in *C. avellana* a short process about half way up the soft (invaginated) portion of the spine, that seems to have no use or meaning, but is probably the representative of the second spine in *H. cruciata* (*asella*). The principal one of these, that is the longer and rather thicker one, inclines slightly backwards, and is altogether of a length about equal to $\frac{3}{5}$ of the diameter of the larva, or about 0·13 mm. The shorter and rather more slender one, which might be regarded as a branch of the other, but which is more nearly equal than that description would imply, points decidedly forwards. The larger branch terminates in a three-spined point, and has several very minute points on its stem; the smaller one terminates usually in two points. The lateral spines appear to be simple (as regards branching), and expand terminally into a three-spiked coronet (Chapman).

Variation of larva.—The larva varies very much. Its ground colour is sometimes yellowish instead of green, and the cross on the back light red, flesh-coloured, or yellow tinged with red on the edges. Occasionally it is interrupted by the ground colour (Borkhausen).

Cocoon.—In confinement the cocoon is sometimes placed on a dried beech leaf, but is more frequently spun very tightly into the forks of beech twigs, and Hewett states that neither he nor Tate could ever find them in the wilds. It is about a quarter of an inch long, two lines broad, and of a very short elliptical form. It is firm in texture, and bears a remarkable resemblance to a gall excrescence. A few fine threads form a kind of network around its base, and attach it to the leaf. It is of a dark, dull brown colour, with blotches of a pale grey or dirty white, spreading irregularly over the upper surface. Buckler says it looks as if it bore a delicate lichenous growth. Fletcher observes that this mottling accurately matches the beech bark. The cocoon is lined inside with pale yellow silk. The larva remains unchanged in the cocoon from October until the following May or June, the pupal stage lasting only about a fortnight.

Pupa.—Structurally, the pupa is very like that of *Cochlidion avellana* (*testudo*), but the eye-collar is remarkably well-developed, stretching right across from the antennæ to the mouth-parts, and on dehiscence it remains attached to the head coverings. Buckler describes it as a trifle less than a quarter of an inch long, and thick in proportion, the abdomen bent under, giving the pupa a rather rounded form; the wings and appendage cases, not attached to the abdominal segments beyond the second; the abdominal segments distinct, as also the parts of the head and thorax, whilst the wing-cases are well-developed and projecting. The surface of the pupa is smooth, polished, and of a transparent whity-brown colour.

Dehiscence.—According to Chapman, the dehiscence is identical with that of the pupa of *Cochlidion avellana* (*testudo*).

Food-plants.—Oak, beech and black poplar (Borkhausen), poplar (Stainton), birch (Fletcher), hornbeam (*Carpinus*) (Hering), hazel and lime (Wocke), *Prunus padus* (Nolcken).

Parasites.—*Sagaritis declinator*, Gravenh., and *Limneria unicincta* Gravenh. (Bignell).

Habits and habitat.—This species is found in beech woods in the southern counties of England, and flies in the afternoon sunshine, looking, it is said, very much like a Tortricid moth, although Eedle states that of very many caught in Epping Forest in June, 1861, only one was flying in the sun; the rest were beaten from beech. Battershell Gill says that the male flies swiftly along the ridings of Epping, and, in his experience, is never beaten out.

Time of appearance.—The imagines appear during June and July from larvæ that have fed up the previous July-October, remained unchanged in their cocoons all winter, and pupated in May-June. This species (unlike the last) is very uncertain in its appearance. It was especially abundant in 1856 (Stainton), moderately abundant at Lyndhurst in 1884, almost absent in 1885, 1886, 1887, a few in 1888, very rare in 1889, 1890, 1891, in great abundance (some hundreds of larvæ being taken) in October, 1892. The larvæ are full-fed in late September and October (September 22nd, 1892, October 26th, 1895, etc.). Imagines have been recorded as having occurred on June 28th, 1859, in New Forest (Bryant), June 28th, 1860, in New Forest (Farren), June 22nd, 1861, at Loughton, May 22nd-26th, 1893, bred from New Forest (Fenn), July 3rd, 1873, Crabbe wood (G. M. A. Hewett), May 22nd-June 1st, 1876, June 3rd-18th, 1877, bred from beech (A. H. Jones), August 14th, 1879, at Lyndhurst (Sheldon), July 10th, 1885, June 6th, 1893, in New Forest (Lowe), July 22nd, 1887, nr. Arundel (Fletcher), June 20th, 1890, nr. Plymouth (F. Briggs), July 5th ,1892, June 14th, 1893, in New Forest (Bankes), commenced to emerge June 9th, 1897, from pupæ from Colchester (Riding), bred many from May 10th-31st, 1897, emerged 11 a.m.-2 30 p.m. (Tutt), Boheman notes it, June 10th, at Degeberga, and July 29th and 31st (*in cop.*), at Sjobo; June 28th, 1877, at Wladiwostok (Christoph *teste* Staudinger).

Localities.—Bucks: around Marlow, beech woods (Bernard-Smith). Devon: Plymouth (Basden-Smith), Plym Valley (F. Briggs), Kimpton (Rudd). Essex: Loughton (Fenn), Epping Forest (Gill, Eedle). Hants: Lyndhurst (Stainton), Crabbe wood (Raynor), Winchester (Hewett), Woolmer Forest (Barrett). Surrey: Horsell (Tugwell). Sussex: Wakehurst, Abbott's wood (Barrett), Worthing (Stainton), nr. Arundel (Fletcher).

Distribution.—Amurland: Wladiwostok, Charabowska (Christoph *teste* Staudinger). Austria: Dalmatia (Wocke and Speyer), Hungary, Carniola, Vienna (Speyer). Belgium (Fologne). Denmark: rare (Aurivillius). France: Corsica, rare (Curò), nr. Paris, Depts. of Maas and Doubs (Speyer). Germany: Leipzig, Weimar, Ratisbon (Knapp and Speyer), Oberhessen, nr. Giessen, Nassau (Kayser), Pomerania, nr. Vogelsang, Messenthin (Hering), Thuringia, Erfurt, Jena (Knapp), Konigsberg, Danzig, Mecklenburg, Strelitz, Lüneburg, Berlin, Dessau, Waldeck, Hanover, Kurhessen, Breslau, Glogau, Wiesbaden, Heidelberg, Karlsruhe, Würtemburg, Augsburg (Speyer), Saxony (Constant). Italy: moderately common in the northern, central and southern provinces (Curò), Turin, Naples (Speyer). Russia: Livonia (Speyer and Wocke), Sarepta (Wocke), Bielsteinshof (Nolcken), Kasan and Volga districts (Speyer), Transcaucasia-Borjom, Lagodckhi (Romanoff). Scandinavia: South Sweden (Speyer and Reuter), Degeberga, Sjobo (Boheman). Switzerland: Cantons Berne, Aargau, St. Gallen (Täschler), Zürich, above the Klus, Katzentisch (Rühl).

Superfamily IV: ANTHROCERIDES.

This superfamily was included in the *Sphinx-béliers* of Geoffroy, and the *Sphinges-Adscitae* of Linné, Esper, Borkhausen, etc. Linné's group, *Adscitae* included (*Sys. Nat.*, 10th ed., p. 494) *filipendulae*, *phegea*, *creusa*, *polymena*, *cassandra*, *pectinicornis*, and *statices*, *i.e.*, according to our modern views, representatives of the Anthrocerids, Syntomids, Euchromiids, Chalcosids and Procrids. The genus *Zygaena*, Fab., also included not only the then known species now referred to this superfamily, but an Arctiid section represented by *phegea*, and individual members of other important and widely divergent families. Scopoli, in 1777, diagnosed (*Introd. Nat. Hist.*, p. 414) the Burnet moths proper under the name *Anthrocera*, and Ochsenheimer, in 1808, referred the Arctiid section represented by *phegea* to his genus *Syntomis*. Hübner differentiated the true Burnets, and divided (*Verz.*, pp. 116-118) the then known European species into no less than eight genera, whilst Boisduval, in 1829, monographed the group, calling (*Mon. des Zygaenides*, pp. 26 and 107) the Anthrocerid members *Zygaena*, and the Arctiid members, *Syntomis*. Staudinger, in 1871, placed (*Cat.* pp. 44 and 50) these sections in different families, but Kirby maintained (*Cat. Lep. Het.*, p. 62) these two divergent elements in his *Zygaenidae*, as late as 1892, calling the Anthrocerid section—*Adscitinae*, *Anthrocerinae*, *Pyromorphinae*, etc., the Arctiid section *Zygaeninae*, etc.

The Anthrocerids (or Zygænids, as they are more generally called) form then a superfamily of moths, which, from the remarkable similarity in colouring and markings of the imagines, have long been erroneously united with an Arctiid family, the *Syntomidae* (and *Euchromiidae*). This union has recently been shown to be entirely unwarranted, there being no real alliance between the two groups, the Anthrocerids, in all their stages, being exceedingly generalised moths belonging to Chapman's *Incompletae*, whilst the Syntomids are highly specialised members of the Arctiid group, and not only fall into the *Obtectae*, but belong to an entirely different stirps from that of the Anthrocerids. We are forced, therefore, to the conclusion, that the similarity of coloration and pattern have been evolved independently in the two groups.

It becomes, therefore, a matter of importance to know the group to which the term *Zygaena*, Fabr., *Syst. Ent.*, p. 550 (1775) is applicable. According to Kirby, *phegea* must be considered the type of *Zygaena*, Fabr., a mixed genus, comprising generalised (Anthrocerid) and specialised (Syntomid) species. This genus contains in order, "*filipendulae*, *phegea*, *ephialtes*, *annulata*, *caffra*, *guineensis*, *cerbera*, *thetis*, *fenestrata*, *cassandra*, *eryx*, *melissa*, *polymena*, *lethe*, *fausta*, *infausta*, *pugione*, *pectinicornis*, *pylotis*, *auge*, *capistrata*, *diptera*, *halterata*, *tibialis*, *pholus, statices, acharon, styx*," a sufficiently heterogeneous lot of species. According to Kirby, the term *Zygaena* goes to the Arctiid series, and *Anthrocera*, Scopoli [*Introd. Hist. Nat.*, p. 454 (1777)] becomes the correct generic title for the Burnet moths, whilst their superfamily name becomes ANTHROCERIDES. There are three very well known subfamilies of the group, the *Anthrocerinae*, *Adscitinae* (*Procrinae*), and the American *Pyromorphinae*. Concerning the two latter, doubt has been expressed whether they should not be united into a single subfamily, and at most form two separate tribes of it. Packard considers the Adscitids to be more generalised than the genus *Anthrocera*, and he says that, judging from the neuration, he considers that *Harrisina* has undergone little more modification than *Ino*. He adds: "*Pyromorpha* also seems rather more primitive than *Zygaena* (*i.e.*, *Anthrocera*), and I see no reason for regarding *Pyromorpha* as the type of a distinct family."

The Anthrocerid ovum is oval, with a depression on the upper surface. It has a very delicate, transparent shell, yellow in colour, but remarkable for the fact that the yelk is usually collected at one pole of the egg, leaving the other pole transparent. There is little trace of ornamentation on the shell (the surface, however, is finely reticulated in *Adscita*, *Harrisonia*, *Aglaope* and *Pyromorpha*); and Chapman thinks that the whole egg looks so soft and unprotected, that it seems more suited for an internal situation, than for the exposed position in which it is laid.

The Anthrocerid larva is remarkable as being the only representative of the *Incompletae* that has the Macro form of abdominal proleg, *i.e.*, with terminal hooks on the inner side only. Dyar describes the larva (under the superfamily name of ANTHROCERINA) as having "the tubercles converted into warts, or absent; i and ii, as well as iv and v, approximate or consolidated." This author, however, includes the Pterophorids (Plume moths) in the superfamily.

The pupa of the Anthrocerids has the 3rd, 4th, 5th, 6th (and in the male, the 7th) abdominal segments free, probably also the 1st and 2nd. It very markedly opens the other incisions on dehiscence. The appendages are only loosely attached; the maxillary palpus (eye-collar) is nearly or quite obsolete, but the dorsal head-piece is well-developed. On dehiscence, the head parts are united together, and separated from the other pupal structures, the glazed eye, however, being retained with the head-parts, the internal pupal linings are very distinct, the pupa also comes out some distance from the cocoon before the emergence of the imago.

The imago is generally brilliantly coloured, but there are some striking exceptions. The species of *Anthrocera* have, usually, metallic green or blue fore-wings, with brilliant crimson spots or streaks, and crimson hind-wings, with a dark border. The species of *Adscita* (*Procris*) have the fore-wings generally of an uniform green colour, with dark hind-wings. In the species of *Pyromorpha* the wings are usually of a smoky-brown colour, with their bases sometimes of a reddish or yellow hue. The fore-wings are long compared with their breadth, and the neuration is very generalised. The antennæ of the Anthrocerids proper, and Adscitids, show many marked differences, but those of the Pyromorphids and Adscitids are very close together, the intense blackness of the former, noted by Bodine (*Antennae of Lepidoptera*, p. 33), is found in the latter, and even the scales on the pectinations are dark fuscous. Griffiths says that the Anthrocerid frenulum shows some peculiarities. The spine is not so strong as that of the Sphingids, and, instead of passing through a regular loop, it fits into a sort of pocket attached to the costal nervure of the forewings, the point of the spine sometimes, but not always, just appearing through the end of the pocket. He adds that *Adscita* (*Procris*) agrees with *Anthrocera*, and the American and other foreign examples examined do not differ from our British representatives in this respect.

Kirby says that "the South African *Anthrocerinae* have been divided into several genera, differing slightly from *Anthrocera*. In *Arichalca*, the fore-wings are marked with red transverse bands, bordered by black lines instead of being spotted, or longitudinally streaked. Three species from south-eastern Africa have been referred to the latter genus. Except the Mediterranean species of true *Anthrocera*, all the African *Anthrocerinae* and *Adscitinae* appear to be found in southern or eastern Africa, and, of the latter, only one or two species have been recorded from tropical regions. In west Africa these subfamilies do not appear to be found at all."

The Burnets proper are especially abundant in the Mediterranean district, but are found practically throughout the Palæarctic region, whilst Kirby says that one or two species touch the north-western frontiers of India, and a few species are South African, the latter, however, appearing not to be gregarious like the European species. The Adscitids also are especially abundant in Europe and the Mediterranean district, but they spread over the whole Palæarctic area, extend into the East Indies, Australia and Tasmania, and reappear in Central and South America. The Pyromorphids appear to be confined to America, extending throughout the greater part of both North and South America. The European *Aglaope infausta*, however, is probably a Pyromorphid.

Family: ANTHROCERIDÆ.

The family may be diagnosed as follows:—

Ovum.—Ovoid in form; shell delicate, transparent; usually pale yellow or greenish in colour; surface smooth or delicately reticulated.

Larva.—Body flattened ventrally; in 1st skin tubercles generalised; in 2nd and subsequent skins the tubercles converted into warts, bearing many finely spiculate hairs; prolegs of Macro type.

Pupa.—Free abdominal segments (1, 2 ?) 3, 4, 5, 6, 7 (in male), (1, 2 ?), 3, 4, 5, 6 (in female); maxillary palpus nearly, or quite, obsolete; dorsal head-piece well developed; enclosed in a cocoon.

Imago.—Tongue developed; antennæ more or less thickened towards apex, or ciliated; labial palpi ascending, the terminal joint short and pointed; leg spines ill-developed; frenulum present; neuration very generalised.

The family is represented by two subfamilies in Britain—the *Adscitinae* or Forester moths, and the *Anthrocerinae* or Burnet moths. We have already noted that it is doubtful whether the American species, usually classed as a distinct family under the name *Pyromorphidae*, really form more than a tribe of the *Adscitinae*, to which they appear to be very closely allied. The *Adscitidi* can generally be distinguished at once by the unicolorous bronzy-green colour of the fore-wings, the *Anthroceridi* by their crimson-spotted fore-wings, and crimson-coloured hind-wings. The Adscitid larvæ partially mine into their foodplant when young, and pupate in a cocoon on (or just below) the surface of the earth; the Anthrocerid larvæ are external feeders, and make a silken boat-shaped cocoon, usually attached to a grass culm, or stone. The antennæ, too, offer another point of distinction between the imagines, those of the Adscitids being bipectinated in the male, and serrated in the female, whilst those of the Anthrocerids are gradually thickened from the base almost to the apex, and form a club, which thins off into a fine tapering apical point. There is, however, much resemblance in the clothing of the haired surface of the antennæ in *Adscita*, *Harrisina*, and *Anthrocera*. The first obtain their extra surface by pectinations, the last by having thicker antennæ, with a dense clothing of hairs. Hampson groups (*Moths of India*, vol. i.) the Anthrocerids and Adscitids into one subfamily, and one gathers that *Anthrocera* is the only genus with clubbed antennæ, whilst those with pectinated antennæ are numerous.

Subfam.: ADSCITINÆ.

Tribe: ADSCITIDI.

The difficulties of discriminating between a number of closely allied species, when the species are practically of one uniform coloration, as in those forming the tribe under consideration, and the wings show no markings whatever, are very great. Staudinger found the neuration quite unadapted for specific characters, because the modifications which occur in the species are quite insignificant. The form of the wing does not furnish a good specific character, nor could Staudinger find any specific differences in the legs and palpi. The antennæ, however, enabled him to separate the European species into two main groups: (1) With the antennæ of the male pectinated to the tip. (2) With the last 8-10 joints forming a club. He also found that, on the average, certain species always had a greater number of joints than others. In spite of this, the variation in the number of antennal joints in the same species is very considerable, and differences of from four to six (and sometimes eight) joints are frequently found in the same species. In the first group, the pectinations diminish more or less rapidly in length, only appearing on the subterminal joints as dentations, whilst in the second group, the pectinations of each joint grow together in broad lamellæ, which at first are always notched in the middle, the notches gradually decreasing and disappearing on the penultimate joint, the terminal joint forming a very flat roundish cone. Moreover, these 8-10 terminal joints, which form the so-called terminal club, are not connate, but only lie very close together. According to this arrangement, our British species work out as follows:—I.—Antennæ pointed; anterior wings perceptibly broader anteriorly—*Rhagades globulariae*. II.—Antennæ ending in a club—*Adscita statices*, *A. geryon*. Zeller also remarks on the longer, thinner and more filiform antennæ of *R. globulariae*, and observes that they terminate in a longer point.

Wallengren first used this character for generic subdivision, and diagnosed (*Skand. Heterocerfjärilar*, i., p. 88) the two genera, into which he subdivided the species as follows:—

1. *Ino*, Leach.—Antennæ extrorsum subclavatæ. Lingua cornea longior.
2. *Rhagades*.—Antennæ obsolete fusiformes, apice acuto. Lingua mollis, pectore brevior.

On this division, *globulariae* would fall into *Rhagades*, *geryon* and *statices* in *Ino* (*i.e.*, *Adscita*). Aurivillius appears to be the only author who has followed this grouping.

Bowell states (*Entom. Record*, etc., ix., p. 27) that in *Adscita* (*Ino*) the scales are generally small, scantily distributed, and rarely bifid, and those of the lower wings are less highly specialised than those of the upper. The scales of *A. chloros* are the simplest, those of both upper and lower wings being plain, strap-shaped. The scales of *A. tenuicornis*, *A. pruni* and *A. chrysocephala* form a middle group, with the scales of the lower wings simple, those of the upper bifid. *A. budensis* has peculiar scales, those of the lower wings are exceedingly small, whilst those of the upper wings have their ends decorated with a number of small points, *viz.*, the ends of the columns separated by the striæ. This peculiarity is visible in the other species, though to a much smaller extent. The scales of *A. ampelophaga* are the most highly developed of those examined, those of the lower wings being bifid, those of the upper trifid, occasionally even quadrifid. We have previously (*Brit. Noctuae*, etc., ii., p. xvi.) discussed the peculiar phenomenon observed when species of this genus are enclosed in a damp box, the green scales becoming changed into a bronzy or red-brown colour.

So far as our British species are concerned, the eggs are so similar that Chapman could distinguish no difference between them, except in size. The newly-hatched larvæ, too, are practically identical. The pupæ, also, are very similar, but these similarities, and such differences as exist, will be best obtained from the detailed accounts of the larva and pupa of each species that follow.

It is well-known that cross-pairing occasionally occurs among the various species of the genus *Anthrocera*, but Oberthür states (*Lép. des Pyrénées*, p. 31) : "Nous avons même trouvé une *Zygaena filipendulae* solidement jointe à une *Procris !* Nous aurions eu de la peine à croire une pareille énormité, si nous ne l'avions nous-mêmes observée et si nous n'avions tenu par les antennes la *Zygaena* entraînant la *Procris* soudée avec elle."

Gynandromorphous examples of this tribe have been recorded by Slater in *A. geryon* (right ♂, left ♀), from Britain ; in *A. ampelophaga* by Schultz [(1) right ♂, left ♀, (2) left ♂, right ♀], from Hungary; in *A. pruni*, by Schultz (right ♂, left ♀), from Pesth. At least seven gynandromorphous examples of the two latter species have been noticed.

Genus : ADSCITA, Retzius.

Synonymy.—Genus : *Adscita*, Retz., "Gen. et Spec. Ins.," pp. 8, 35 (1783) ; Kirby, "Cat. Lep. Het.," p. 81 (1892) ; Handbook, etc., iii., p. 97 (1897). *Sphinx*, Linn., "Sys. Nat.," 10th Ed., p. 495, in part (1758) ; "Faun. Suec.," p. 290, in part (1761) ; Scop., "Ent. Carn.," p. 189, in part (1763) ; Hufn., "Berl. Mag.," ii., p. 186 (1767) ; Denis and Schiff., "Sys. Verz.," p. 308 (1776) ; Fuessly, "Mag. Ent.," i., p. 115 (1778) ; "Neues Mag.," ii., p. 210, in part (1785) ; Esp., "Die Schmett.," ii., p. 158, in part (1780) ; Bork., "Sys. Besch.," ii., p. 33, in part (1789) ; Hb., "Eur. Schmett.," ii., figs. 1, *et seq.* (? 1797), p. 76 (? 1805). *Phalaena*, Fourc., "Ent. Par.," ii., p. 292 (1785). *Zygaena*, Fab., "Sys. Ent.," p. 550, in part (1775) ; "Mant. Ins.," ii., p. 107, in part (1787) ; Schrank, "Faun. Boica," ii., p. 242, in part (1801) ; Haw., "Lep. Brit.," p. 73, in part (1803). *Chrysaor*, Hb., "Tent." (1806). *Procris*, Fab., "Ill. Mag.," vi., p. 289 (1807) ; Latr., "Gen. Ins.," iv., p. 213 (1809) ; Godt., "Lép. France," iii., p.156 (1821) ; Hb., "Verz. bek. Schmett.," p. 119 (? 1822) ; Bdv., "Ind. Meth.," p. 38 (1829) ; "Icones," ii., p. 78 (1834) ; "Hist. Nat. Lép.," i., p. 118

(1836) ; Dup., "Lép. France," suppl., ii., p. 92 (1835) ; "Cat. Meth.," p. 53 (1844) ; H.-Sch., "Sys. Bearb.," ii., p. 26 (1845) ; Sta., "Man.," i., p. 78 (1857) ; Ramb., "Cat. Lep. And.," p. 182 (1866) ; Newm., "Brit. Moths," p. 22 (? 1869) ; Druce, "Biol. Cent. Amer. Lep.," i., p. 37 (1884) ; Meyr., "Proc. Linn. Soc. New S. Wales," p. 792 (1886) ; "Handbook, etc.," p. 449 (1895) ; Buckler, "Larvæ," etc., ii., p. 87 (1887) ; Auriv., "Nord. Fjär.," p. 51 (1888). *Atychia*, Ochs. and Treits., "Schmett. Eur.," ii., p. 9 (1809) ; x., p. 100 (1834) ; Freyer, "Neuere Beitr.," i., p. 27, etc. (1833) ; Zell., "Isis," 1839, p. 274 ; Evers., "Faun. Lep. Volg.-Ural.," p. 91 (1844) ; Nick., "Stett. Ent. Zeit.," vi., p. 93 (1845) ; Assmann, "Abbild. und Besch. der Schmett. Schles.," ii., p. 5 (1845). *Ino*, Leach, "Edin. Enc.," ix., p. 436 (1815) ; Stephs., "Illus.," i., p. 105 (1828) ; Curt., "Brit. Ent.," ix., pl. 396 (1832) ; Wood, "Ind. Ent.," p. 11 (1839) ; Led., "Ver. zool.-bot. Ges. Wien," ii., p. 102 (1852) ; Speyer, "Geog. Verb. Schmett.," i., p. 466 (1858) ; Hein., "Die Schmett. Deutsch.," p. 152 (1859) ; Staud., "Stett. Ent. Zeit.," xxiii., pp. 344 *et seq.* (1862) ; Wallgrn., "Scand. Het.-Fjär.," pp. 88, 108 (1863) ; Newm., "Zool.," p. 8403 (1863) ; Dbldy., "Ibid.," p. 8532 ; Sta. and Staud., "Ent. Ann.," p. 95 (1864) ; Snell., "De Vlinders," etc., p. 124 (1867) ; Nolck., "Lep. Fn. Estl.," i., p. 97 (1868) ; Staud. and Wocke, "Cat.," p. 44 (1871) ; Mill., "Cat. Lép. Alp.-Mar.," p. 124 (1872) ; Curó, "Bull. Soc. Ent. Ital.," vii., p. 192 (1875) ; Sand, "Cat. Lép. Auv.," p. 21 (1879) ; Peyer., "Cat. Lép. Als.," p. 46 (1880) ; Frey, "Lep. der Schweiz," p. 63 (1880) ; Hofmn., "Die Gross-Schmett.," etc., p. 32 (1887) ; "Die Raupen," etc., p. 34 (1893) : Tutt, "Brit. Moths," p. 350 (1896). *Aglaope*, Dalm., "Vet. Akad. Handl.," 1816, p. 211 ; Zett., "Ins. Lapp.," p. 920 (1840).

Until quite recently the whole of the Palæarctic Foresters have been known under one or other of the synonymic generic titles, *Procris*, Fab., or *Ino*, Leach. Kirby, however, in 1892, resurrected the older name, *Adscita*, Retzius, for the whole of the Palæarctic (and some exotic) species. The diagnosis of Retzius reads as follows :—

Adscita.—Papillon Phalène. Ant. clavatæ. Alæ subdeflexæ, invicem incumbentes (*Gen. et Sp. Ins.*, p. 8).

Retzius cites (*Ibid.*, p. 35) *Adscita aries* (*A. filipendulae*) and *A. turcosa* (*A. statices*) in this genus. As *filipendulae* is the type of Scopoli's *Anthrocera*, it leaves *statices* as the type of *Adscita*. Although Retzius was the first to use *Adscita* in a generic sense, earlier authors (including Linné and Esper) had called the Adscitids and Anthrocerids the *Sphinges-Adscitae*, which is, in reality, the oldest group name of the superfamily.

The distinctive characters of the genus as apart from *Anthrocera* are :—

Ovum.—Surface of shell more distinctly covered with a fine polygonal reticulation.

Larva.—The hairs on tubercles i, ii with a bulbous swelling near base in 1st stage (? in later stages).

Pupa.—Flattened ventrally.

Imago.—Antennæ pectinated, forming a pseudo-club at apex.

With the exception of certain species from South Africa (comprising the genera—*Orna*, Kirby, *Crameria*, Hb.), North America, (*Tantura*, Kirby), Central America (*Pseudoprocris*, Druce), South America (*Anatolis*, Feld.), India (*Debos*, Swinhoe), and Australia (*Hestiochora*, Meyr.), all the remaining Adscitids are included in the genus *Adscita*, Retz., by Kirby (*Cat. Lep. Het.*, pp. 81-86). He has, however, not adopted the genus *Rhagades*, Wallgrn. Nevertheless, it seems probable that when some special study of the group has been made, and some reliable characters found apart from wing colour and shape, and when the life-histories of more species are completely known, the genus *Adscita*, Kirby, will be found to be composed of many heterogeneous elements. The genus, as it stands, comprises species from almost all parts of the globe, and Kirby states that the species of one or two of the allied South African genera are coloured like *Anthrocera*, from which they differ, however, in the structure of their antennæ.

The Adscitid larva and pupa show considerable resemblance to those of the genus *Anthrocera*. The egg, however, appears to differ essentially from that of *Anthrocera*, the latter being usually smooth, whilst the surface of the Adscitid egg is distinctly reticulated; the eggs of some Anthrocerids, however, appear to be covered with a faint reticulation, if examined with a sufficiently high power. Dyar also notes the Pyromorphid egg (*Pyromorpha dimidiata*) as being covered with a regular rounded reticulation, resembling a series of contiguous circles. The larva, Newman notes, in general appearance, and some of its characters, resembles that of *Cochlidion avellana* (*testudo*).

The imagines of the three British Foresters bear considerable resemblance to each other, the fore-wings of all being of a bright bronzy-green or -blue. They all appear in the imago state in May and June, varying slightly according to the season, each species rarely extending over more than three weeks in the same year, *A. geryon* generally appearing a little later than *R. globulariae*. They are exceedingly localised, and haunt the flowers which are in blossom in their various localities at the time of their emergence, flying only in the bright sunshine. Although so local, they are usually exceedingly abundant where they occur. *R. globulariae*, so far as our present knowledge goes, appears to be far more localised than either *A. geryon* or *A. statices*, the latter being the most widely distributed species. Nicholson says that all the three British species occur on the downs (Cliffe Hill) near Lewes, *A. statices* being there by far the rarest. The imagines all have much the same habit, the males booming along in the sunshine like Burnet moths, whilst the females are very sluggish, and fly but little. The female of *R. globulariae* frequently rests on the flowers of *Poterium sanguisorba*, and that of *A. geryon* on those of the same plant, and *Hieracium pilosella*. The females of these two species are somewhat difficult to distinguish, but the antennæ of *R. globulariae* are longer, thinner, and more pointed towards the tip than are those of *A. geryon*. On the Sussex Downs these species are very uncertain in their appearance, both *R. globulariae* and *A. geryon* being very abundant in some seasons, while, in others, it would be difficult to find a specimen. Weir, speaking of the same locality, says that "all the species may be found within the space of a mile and a half, occurring in their restricted haunts in great abundance, each being confined to its own food-plant. *R. globulariae* and *A. geryon* are mixed together, and *R. globulariae* and *A. statices* are also mixed, but, from the totally different positions in which *Helianthemum vulgare* and *Rumex acetosa* grow, *A. geryon* is never found mixed with *A. statices*." The females are to be obtained by sweeping the grass or searching the flowers on which they rest. Zeller says that *A. statices* and *R. globulariae* differ in habit, for whereas the former flies freely in the sunshine, he had, in spite of fine still weather, to start the specimens of *R. globulariae* out, and he found that after a short flight they settled again on the grass or *Centaurea* flowers. Vaughan records (*Proc. Sth. Lond. Ent. Soc.*, 1890, p. 39) the capture of two individuals in June, 1890, at Edlean Righ, Sound of Jura, which he considered to be intermediate between *A. statices* and *R. globulariae*. The restriction of the latter species in Britain, however, is suggestive that the specimens belonged to the former species. Selys-Longchamps mentions (*Ann. Ent. Soc. Belg.*, xiv., p. 42) examples from Baraque-Michel similar to *A. statices*, but with antennæ like *A. globulariae*. One species, *A. ampelophaga*, that occurs in southern Europe, is said to be very destructive to the vine.

ADSCITA STATICES, Linné.

Synonymy.—Species: *Statices*, Linné, "Sys. Nat.," 10th Ed., p. 495 (1758); "Fauna Suec.," p. 290 (1761); Scop., "Ent. Carn.," p. 190 (1763); Hufn., "Berl. Mag.," ii., p. 186 (1767); Fab., "Sys. Ent.," p. 555 (1775); Fuess., "Mag. Ent.," i., p. 115 (1778); "Neues Mag.," ii., p. 210 (1785); Esp., "Die Schmett.," ii., p. 158, pl. xviii., figs. 2a, b (1787); Bork., "Sys. Besch.," ii., pp. 33 and 167 (1789); Hb., "Eur. Schmett.," ii., pl. i., fig. 1, ? pl. 1 bis, fig. 2 (1797), p. 76 (? 1805); Haw., "Lep. Brit.," p. 73 (1803); Ochs. et Treits.," "Schmett. Eur.," ii., p. 11 (1808); Godt., "Lép. France," iii., p. 158 (1821); Stphs., "Illus. Brit. Ent.," i., p. 105 (1828); Freyer, "Neuere Beit.," i., p. 118, pl. 62, fig. 1 (1833); Curt., "Brit. Ent.," ix., pl. 396 (1832); Bdv., "Hist. Nat. Lép.," i., p. 118 (1836); Wood, "Ind. Ent.," p. 11 (1839); Zell., "Isis," 1839, p. 274; Zett., "Ins. Lapp.," p. 920 (1840); Dup., "Cat. Meth.," p. 53 (1844); Evers., "Lep. Volg.-Ural.," p. 91 (1844); Assm., "Abbild. Schmett. Schles.," ii., p. 5 (1845); H.-Sch., "Sys. Bearb.," ii., p. 27 (1845); Nick., "Stett. Ent. Zeit.," p. 93 (1845); Led., "Ver. zool.-bot. Ges. Wien," ii., p. 102 (1852); Sta., "Man.," i., p. 78 (1857); Speyer, "Geog. Verb. Schmett.," p. 356 (1858); Hein., "Schmett. Deutsch.," p. 154 (1859); Staud., "Stett. Ent. Zeit.," xxiii., p. 353 (1862); Newm., "Zool.," xxi., pp. 8607-8 (1863); Wallgrn., "Scand. Het.-Fjär.," p. 108 (1863); Sta. and Staud., "Ent. Ann.," 1864, p. 103; Ramb., "Cat. Lep. And.," p. 184 (1866); Snellen, "De Vlinders," etc., i., p. 125 (1867); Nolck., "Lep. Fn. Est.," ii., p. 97 (1868); Newm., "Brit. Moths," p. 22 (? 1869); Staud., "Cat.," p. 44 (1871); Mill., "Cat. Lép. Alp.-Mar.," p. 124 (1872); Curò, "Bull. Soc. Ent. Ital.," vii., p. 193 (1875); Sand, "Cat. Lép. Auv.," p. 22 (1879); Kirby, "Eur. Butts.," etc., p. 87 (1879); "Cat. Lep. Het.," i., p. 84 (1892); "Handbook," etc., iii., p. 98 (1897); Frey, "Lep. der Schweiz," p. 64, in part (1880); Peyer., "Cat. Lep. Als.," p. 46 (1880); Hofmn., "Die Gross-Schmett.," etc., p. 33 (1887); "Die Raupen," etc., p. 35 (1893); Buckl., "Larvæ," etc., ii., p. 87, pl. xviii., fig. 1 (1887); Auriv., "Nord-Fjär.," p. 51 (1888); Kane, "Entom.," xxvi., p. 317 (1893); Barr., "Lep. Brit.," ii., p. 112 (1894); Meyr., "Handbook," etc., p. 449 (1895); Tutt, "Brit. Moths," p. 351 (1896). *Turcosa*, Retzius, "Gen. Ins.," p. 35 (1783). *Staticus*, Fourc., "Ent. Par.," ii., p. 292 (1785). *Globulariae*, Schrk., "Fauna Boica," ii., p. 242 (1801).

Original description.—*Sphinx* viridi-cærulea, alis inferioribus fuscis (Linné, *Sys. Nat.*, 10th Ed., p. 495).

Imago.—Anterior wings 21·9-29·3 mm. in expanse, bronzy- or blue-green. Posterior wings smoky-grey. Antennæ rather long, terminating in a blunt club.

Sexual dimorphism.—The male is much larger than the female, the former averaging (in about 50 examples) 29 mm., the latter 22 mm.; the antennæ are more pectinated in the ♂, the body comparatively slender, that of the female being stout and plump.

Variation.—In colour, the specimens present two very distinct forms, the rare (in Britain) blue-green type-form described by Linné, and the common bronzy-green form = ab. *viridis*, n. ab. The reddish-bronze individuals so often seen have usually been produced by exposure to damp, the scales exhibiting a great change in the presence of moisture. Frey's remarks (*Lep. der Schweiz*, p. 64) show that he was much mixed about the species, as he gives the food-plant (*Centaurea scabiosa*) of *R. globulariae*, as that of *A. statices*, and refers *A. chrysocephala* (= *A. geryon*) to the latter species. He, however, states that in the mountains a somewhat smaller, but otherwise typical, race of *A. statices* occurs. Staudinger considers that the most southerly limit of typical *A. statices* is Hungary (Buda and Mehadia), South Germany and the Swiss Alpine regions. Speyer's record from Granada, he asserts, rests on an incorrect determination. He considers the specimens from Asia Minor, central and southern Italy, as not typical. We are in great doubt as to the varietal or specific value of the following aberrations, three of which are accepted by Staudinger as varieties of, and one as typical, *A. statices*. An examination of the specimens of *heydenreichii* and *crassicornis* in the British Museum (amongst which are some of Zeller's and Lederer's original specimens), leads us, from the antennal characters, to believe that they are possibly specifically distinct from *A. statices*, but probably not specifically distinct from each other, the *heydenreichii* being "blue-green," the *crassicornis* "golden-green," thus agreeing with the colour definition of the two forms. We would again point out that the "blue-green" form of *A. statices* is the Linnean type. This form, as already mentioned, is rare in the British Islands, but would appear to be the prevalent colour of local races in the east and south of Europe.

α. var. *micans*, Freyer.—Of the size of *A. globulariae*, but the wings are narrower, not so delicate, nor so truncate. The head, thorax and abdomen are steel-blue, whilst they are green-brown in *A. globulariae* and *A. statices*. The abdomen is much stouter than in the first-named, and more densely scaled. On the underside, the wings are black-grey with steel-blue iridescence, the colour in *A. statices* and *A. globulariae* tending to be grass- or brown-green. On comparison, the difference appears very striking. Taken in the Bavarian Alps, where it was flying in grassy meadows, and supposed at first to be *statices*, but more accurate comparison showed it to be neither *statices* nor *globulariae* (*Neuere Beiträge*, etc., i., p. 27, pl. xiv., fig. 1). Prout notes that "Freyer's figure bears out the points that the author mentions." Staudinger treats (*Cat.*, p. 44) it as typical *statices*, whilst Lederer considers *micans* = *mannii*, which it would therefore antedate. Herrich-Schäffer notes var. *micans* from "Turkey." Millière notes (*Cat. Lép. Alp.-Mar.*, p. 124) *mannii* as being "rare in the Basses-Alpes in May, the larva in April, on *Cistus salvifolius*, of which it eats the leaves without touching the flowers," this probably is an error. Speyer notes it from Italy, the southern Tyrol, Botzen, Buda, Sandwald and Aspromonte.

β. var. *mannii*, Led.—Of the size and robustness of *A. statices*; antennæ much as in that species, but somewhat shorter. The fore-wings rather more rounded at the tip and anal angle; the margin more sinuated, the colour an intense blue-green. The hind-wings black-grey, and of a somewhat more metallic green than in *A. statices*, not paler towards the base; the fringes not darker. The underside black-grey. Mann brought this form in quantity from Spalata, and they were all precisely similar in shape and colour (*Ver. zool.-bot. Ges. Wien*, 1852, p. 103). Staudinger says (*Hor. Soc. Ent. Ross.*, vii., p. 101) that this is decidedly a form of *A. statices*, since the two run into each other completely. He records it as being common at Karpinisi in the latter half of June, and states that some of the small Grecian specimens are not distinguishable from German *A. statices*. Staudinger gives (*Cat.*, p. 44) the distribution as: Carniola, Dalmatia, Greece, Central Spain. Curò records *mannii* from the mountain regions of Lombardy, Tyrol, etc., also from Sicily. Reutti notes May 28th, 1882, nr. Dinglangen, in Nassau, etc.

γ. var. *heydenreichii*, Led.—This comes from the neighbourhood of Mehadia, and bears much resemblance to *mannii*, but is rather larger and much stouter, the antennæ are thicker and longer, but otherwise similarly formed; the dark blue-green fore-wings are shorter and broader, the costa and inner margin of almost equal length, the hind margin very convex, the hind-wings and underside as in *mannii*. This insect varies in colour to the most beautiful shiny golden-green, which specimens Dr. Frivaldsky sent as *micans*, Frr., although I do not look upon it as the latter, for Freyer found his species on the Bavarian Alps, but Frivaldsky's specimens came from Italy, and the East; besides, Freyer's figure does not agree in other details. This figure is too badly drawn to pronounce a positive opinion, but I am inclined to suspect that it is an ordinary *statices* (*Ver. zool.-bot. Gesel. Wien*, 1852, p. 103). Staudinger, in the *Stett. Ent. Zeit.*, xxiii., p. 358, after noting that the south Tyrolean specimens referred to *heydenreichii* were taken with typical *A. statices*, notes that true *heydenreichii* is always "stouter than *statices*, its antennæ longer and thicker, but, on the whole, not so much so as in var. *crassicornis*." He also says (*Hor. Soc. Ent. Ross.*, vii., p. 101) that specimens were found in Attica, on April 25th, and can only, on account of their deep blue colour, be referred here, although the specimens are small (22-24 mm.). He also notes it as found by Erber, in Corfu. In his *Cat.*, p. 44, it is described as "*var.* major, al. ant. cæruleis, al. post. aterrimis," and is recorded from the "southern Alpine valleys, Hungary, south-east Balkans, Bithynia, Armenia." Bachmetjew gives nr. Sofia, and Frey says that *heydenreichii* occurs at Siselen (*teste* Rätzer), and south of Monte Rosa (*teste* Staudinger), whilst Herrich-Schaffer gives Dalmatia, and Lederer mentions Mehadia, and Carniola. Rambur says that Spanish specimens most resemble *heydenreichii*, sent by Lederer to him as coming from Beyrout. Sand gives the hills of Crevant as a locality. Gumppenburg mentions the Mangfall district, and Caradja notes Ciucorova.

δ. ? var. *crassicornis*, Staud.—Of five specimens in Staudinger's collection, four were obtained from Weissenborn (and were without exact locality), the fifth was from Zeller, and labelled "Livorno, Orient." The specimens measure, with the exception of the very short-winged female, 30-32 mm. in wing expanse, are exceptionally robust, and have exceedingly thick antennæ. The colour of the fore-wings is of a very deep gold-green, the hind-wings blackish, with light green folds on the upperside, and distinct green shading on the underside. Both Zeller and Mann, in commenting on specimens from Messina and Palermo, mention the thick antennæ, and these might belong here; so also might small specimens from Florence, and others from Dalmatia. More material is required to form a satisfactory conclusion (*Stett. Ent. Zeit.*, xxiii., p. 359). In his *Cat.*, p. 44, Staudinger describes it as "*var.* crassior, anten. mult. crassioribus. al. ant. cærul.-viridibus. Sp. Darwin. ? From southern Turkey and south-east Hungary." Kirby treats (*Cat. Lep. Het.*, p. 84) this as a distinct species, referring to Millière, *Ann. Soc. Ent. France* (6), v., p. 119, where it is recorded as occurring at St. Martin Lantosque, at 1,200 m.

ε. var. *minor*, Evers.—Alæ anticæ viridi-aureæ basi thoraceque cæruleis. In campis Orenburgensibus (*Fauna Lep. Volg.-Ural.*, p. 91).

ζ. var. *uralensis*, Grum-Grschimailo, "Hor. Ent. Ross.," xxvii., p. 385.—Antennis capite corpore et alis anticis caeruleis. In montibus—ad Mijass anno 1888 collecta.

EGGS.—The eggs are laid in little masses of 20 or 30, regularly placed and close together, side by side, sometimes, however, in rows of four or five, arranged somewhat irregularly. They are oval in outline, much depressed on the upper surface, bright yellow in colour, and very delicate in appearance; roughly furrowed or wrinkled longitudinally, and covered over with a minute network of polygonal (? hexagonal) reticulations. Horton says they are oval, rather flattened, and slightly but irregularly ribbed longitudinally. Hellins states that each egg is placed on its flat side, and is in form oblong and flattened, being about ·85 mm. long, ·5 mm. wide, and ·25 mm. deep, with the ends rather rounded, and the upper side somewhat sunken. The shell is wrinkled longitudinally, and rather shining; the colour, at first, is light yellow; this becomes paler, and at last the head of the larva shows at one end as a dusky spot. The larva frees itself by eating out one end, but leaves the empty shell otherwise untouched. Eggs laid on June 9th, 1864, hatched on July 4th (Horton).

HABITS OF LARVA.—The habits of the larva of this species were first studied by Horton, who discovered, in 1864, that the young larvæ mined in both the upper and under sides of sorrel leaves, some buried far between the upper, and under epidermis of the leaf, others with their tails out, and always trailing after them a thread of black excrement. In 1865, Doubleday filled the brick pit of a hot-bed with soil, planted it with *Rumex acetosa*, and covered the soil between the plants with moss. He placed eggs (laid by captured females) on the sorrel plants, and soon had the satisfaction of seeing the young larvæ "mining" the leaves of the sorrel. With winter, the leaves died off, the larvæ hid themselves, and the pit was left open to the weather. In the spring of 1866 he could find no trace of them, until, on May 5th—a day of sunshine after a night's frost—he was passing the pit at about 11 a.m. and saw about 20 larvæ nearly full-fed, feeding close together and enjoying the sun. By searching he then found a great many more. He then observed that they ate the lower leaves of the sorrel, but was unable to find the larvæ at large, although there must have been hundreds in the field when the search was made. Hellins confirmed the statement that the larvæ, when very small, burrowed into the substance of the leaf, although he never saw them quite hidden. He stated that they soon made transparent blotches by eating away the under, and occasionally the upper, epidermis of the leaf, leaving the skin on the other side untouched and quite filmy, and they retained the habit of making blotches until late autumn, when they hybernated, although they often ate at this time quite through the substance of the leaf. Moulting appears to be effected by means of an opening in the front of the old skin near the head.

LARVA.—*Newly hatched* (*May* 16*th*, 1898, parents from Auribeau, nr. Cannes). Head black, polished, small and retractile. Body short, slug-shaped, segments distinct, no subsegments indicated. Tubercles single-haired, hairs very long, tapering, thorny, tubercular bases very tall, dorsal tubercles i and ii placed trapezoidally on 2nd and 3rd thoracic and abdominal segments, and somewhat closely together, owing to narrowness of segments; hair-bases bulbed. The supraspiracular, iii, consists of two tubercles, one of which, on the 1st abdominal, carries two hairs, making three supraspiracular hairs on this segment. The spiracles not distinguishable, but two subspiracular tubercles below their normal position, and placed a short distance apart, probably represent iv and v. The ground-colour, at first, pale yellow; the tubercles situated on slightly raised whitish skin areas, which have an appearance of forming whitish bands, thus i and ii are on one band, iii on another, and iv and v on another. The skin-surface is covered with minute spicules. After 17 days the larva, still in first skin, presents a dark medio-dorsal band, a subdorsal, and a faintly-marked lateral one; the areas between these are whitish, and raised into the cushions, which carry the tubercles. *June*, 1898: In the *second skin* the position of the bands is similar, being brownish and better marked, the tubercles, however, are now surrounded by a group of smaller ones; the primitive tubercles in i and ii can be distinguished by their greater size, but they now form members of a single group. The spicules are larger and distinct. Hairs tapering, thorny, grey or white in colour. The head is completely retractile. The segmental incisions deeply cut. The larva with a very Anthrocerid appearance. *August* 11*th*: The larva, in *? fourth skin*, slightly over one-quarter inch in length; the medio-dorsal line faint, white and narrow, bordered on either side by a broad pink line, the whole making a broad pink dorsal band, with a faint medio-dorsal line; on either side of this band is a broad whitish subdorsal band, the lateral area pink. The spiracles pale yellow, rather raised above body surface, and forming a short, blunt tube. The tubercles large, many-haired cushions or warts, i and ii united, iii fairly large, circular, iv and v united, the marginal groups also united, much smaller than preceding. Hairs stout at base, tapering to point, with tall, swollen or bulbed bases, mostly white some black-tipped. Skin covered with pittings, spicules disappeared, but some small black chitinous warts scattered over surface, each carrying from 3-5 short spikes on their circumference. Head retractile, larva rolls up like an Anthrocerid (Bacot). Hellins notes the *newly-hatched* larva as being barely 1 mm. in length, of a fat, stumpy, even figure. The trapezoidal dots are placed on slanting raised tubercles, each dot bearing one long stiff hair. The larva is yellow in colour, the small head looks as if yellow beneath, with a glossy black tinge over it. A week later there is an orange dorsal line, and in two weeks (after the *first moult*), the larva instead of being yellow dorsally, is of a semi-translucent pale brownish tint, with darker interrupted dorsal line, and outside the dorsal tubercles a warm brown stripe, whilst the hairs are a little longer. In another fortnight a *second moult* is passed, and, at the end of seven weeks, the larvæ are 5 mm. long, the skin set with little points, the back pale yellow, the dorsal tubercles darker, the dorsal line dusky, the lateral areas pale brown, with the large lateral tubercles pink. When three and a half months old, the larvæ are 7-8 mm. long, plump, slightly fusiform, with the head small and retractile, the places of the usual tubercular dots occupied by large tubercles set with short bristles, the trapezoidals being united in a pair of transversely elongated tubercles. The skin round the tubercles is set all over with tiny branched points. The head is shining and blackish, the short bristles are dirty-whitish, tipped with brown ; the little points on the skin are shining black, the spiracles yellowish-brown, placed just beneath the large lateral tubercles. The *full-grown larva* is described by Barrett as being about three quarters of an inch in length. The head is shining black, small and retractile; the prothorax much broader, with a dorsal corneous plate ; the body pale green, pale yellow, pinkish, or dirty white; the dorsal line pink, brownish or composed of short brown dashes ; there is also a broad pink or greenish lateral stripe, usually contrasting in colour with the upper part of the body ; the raised spots very broad, forming flat plates, six on each segment, each with a thin radiating fascicle of short, stiff bristle-like hairs, tipped with brown, among which are a few longer, more silky, whitish hairs, the raised spots themselves being pink, pinkish-brown, or pale brown. Chapman says that the *adult larva* is paler dorsally, darker laterally ; a large dorsal boss on each side carrying a *chevaux de frise* of bristles, another on each side below these (supraspiracular), the bristles on these pale, with a clear area around each. Below the supraspiracular tubercles are the spiracles, then a smaller tubercle (or boss). The paler dorsal area is largely owing to the larger clear space around the boss being free frem the minute black points that stud the general surface. Each of these black points is stellate. On the meso- and metathoracic segments, the supraspiracular is represented by two tubercles, the upper being a little the more forward. The segments are rounded, the segmental incisions deep.

VARIATION OF LARVA.—Hellins mentions three types of colouring as existing among five autumn larvæ. (1) With the back dirty white ; the dorsal tubercles slightly brownish ; a dull pink dorsal line ; the dorsal tubercles bordered on the outside with a scalloped brown line, the large upper row of lateral tubercles rose-pink, the two lower rows of small ones more brownish-pink. (2) With the back yellow, slightly brownish dorsal tubercles; lateral tubercles pinkish, the lower ones brownish. (3) With the back pale yellowish, the sides dusky, with very little tinge of pink. Five different forms of the full-fed larva are figured (*Larvae*, etc., ii., pl. xviii., figs. 1-1d) by Buckler.

Comparison of larva of A. statices with that of A. geryon.—So far, I can well separate the larvæ of *A. statices* from those of *A. geryon* by their greater size, their very much brighter colouring, and by the form of the dorsal line, which is not so decidedly a double dark line with a pale centre (Hellins). In structure Hellins failed to find any difference. He further adds that larvæ of *A. geryon* exhibit less variation in colour than those of *A. statices*, and that they seem more active than the larvæ of the latter, unrolling themselves more quickly, and walking off whilst under examination.

Cocoon.—The larva of *A. statices* spins a thin, white, filmy, but tough cocoon, which is attached to stems of plants close to the ground. Chapman says that the cocoon is spun within a little loose outer silk, white (or nearly so) in colour, that it is of a flattened ovoid shape, with a flat, valvular opening, the edges closely drawn together at the anterior end, and a small conical projection at the hinder end, into which the cast larval skin is wedged; the whole sufficiently flimsy to allow the chrysalis within to be easily seen, but without detail.

Pupa.—Pale brown, rather transparent looking, and fairly uniform in tint throughout, about 9 mm. in length, and 4 mm. in breadth; the depth from back to front is less, especially behind the wings, the front being flattened, and more so the front of the free abdominal segments; it is broadest about the middle of the wings (2nd abdominal segment). The head projects forward a little, with some trace of a neck; the maxillæ and third pair of legs project conjointly beyond the wings to nearly the extremity of the pupa; the wings reach to the 5th abdominal segment. The wings and appendages are quite free from the 4th abdominal segment, and apparently also from the first three also, except a portion of the third; these three segments are closely covered by the appendages, and the first two do not appear to move on each other in any ordinary circumstances, and the wings, especially, fit very closely the margins of abdominal segments 1 and 2, and both these segments, where covered, are of very delicate cutaneous structure; still there appears to be no actual soldering of the appendages to these segments. The antennæ, which are of the same length as the wings, meet in the middle line, and so cover all the tarsi of the second pair of legs, and the last joint of the tarsi of the first pair. Between the maxillæ and first pair of legs is a portion of the first femur (or trochanter?). The spiracles are on a distinctly raised fluted margin or flange along the abdominal segments; this flange is, indeed, a large element in the broad flattened character of the pupa. In this respect, however, the pupa is not so exaggeratedly flattened as the pupa of the American representatives of this group. As distinguished from the pupæ of most groups of Lepidoptera, this pupa has the spiracle of the first abdominal segment just visible behind the wings, whilst the second, usually exposed, is beneath the wings, but visible through them, owing to their transparency. Dorsally, there is a narrow head-piece, broadest against the antennæ, nearly evanescent in the middle line. There are no obvious markings or hairs on the thoracic or first two abdominal segments, but the abdominal segments 3-7 have each, along their dorsal margin, and terminating laterally against the marginal flange, a row of spines. These are dark brown in colour, almost black, are about 50 in number on each segment, and are directed backwards from the top of a somewhat raised ridge, which may be regarded, however, as the bases of the spines. The spines vary a little in size, but without any very definite order, and are rather larger midway between the dorsum and the side. On the 8th abdominal segment is a similar row, but smaller, owing to the smallness of the segment, and terminating at about the same point in the segment, though the lateral flange terminates on the previous segment; a still smaller row is found on the 9th abdominal segment. The remainder of the 8th, 9th and 10th abdominal segments is smooth, except the median cicatrices on 9 and 10. These three segments in the pupa described are fused together, the individual being a male. It is noticeable that the bases of the maxillæ, instead of forming a nearly transverse line, extend upwards in the middle line, so that the grooves between them and the cheeks are in line (inwards) with the groove on the other side, between the cheeks and clypeus, forming a St. Andrew's cross, the centre just below the labium. Similarly the external angle extends upwards as well as outwards, nearly reaching the antennæ, and is a distinct trace of the base of the maxillary palpi (Chapman, *in litt.*, June 8th, 1897).

Dehiscence.—In dehiscence, the antenna-cases remain attached to the head, but free throughout their length. The third pair of legs are quite separate, and the wings are separate from the other appendages, but the head, eyes and other front appendage-cases remain soldered together. The dorsal head-piece remains attached to the 1st thoracic segment, but free from the eye-covers. The dorsal slit extends backwards nearly to the posterior margin of the metathorax. The appendages are now obviously free from the first abdominal segment (Chapman).

Food-plant.—*Rumex acetosa*. [Reputed also, by Kaltenbach, to feed on *Helianthemum vulgare* (= food-plant of *A. geryon*), *Rumex acetosella*, *Centaurea scabiosa* (food-plant of *R. globulariae*), *Globularia vulgaris*. Millière says "many low plants," and gives *Cistus salvifolius* as food of the larva of the var. *micans*. We found this form near Cannes (on Millière's own ground), in April, 1898, obtained eggs, larvæ from which fed in most approved fashion on *R. acetosa*. The imago sits on *Cistus* flowers, and probably this misled Millière.]

Habits and habitat.—Meadows and pastures, especially on the outskirts of woods, are the favourite haunts of this species. Forty years ago it was abundant in Hammersmith marshes (Taylor). On the Sussex Downs it is found in a sheltered valley known as Oxsteddle Bottom, but this locality is very unlike its usual meadow haunts, and in Guernsey it is confined to patches a few yards square on the southern cliffs; near Brighton it is found in Hollingbury Combe, a place overgrown with long tangled grass, whilst about three miles from Gloucester it occurs in a damp vale abounding in sorrel. In the New Forest it occurs on the railway bank, and at Chingford it frequents a low-lying damp field at the back of the "Woodman," and settles here (as elsewhere) on the flowers of *Lychnis flos-cuculi*. At Hemsby, near Yarmouth, it is found on the sand-hills, which are covered with marram grass, sea-buckthorn and blackberry. At York it is found on rough grassy fields about Strensall Common, at Bramshall, in a damp meadow near a small stream, whilst at Hartley Wintney, also, it occurs in a boggy meadow by the side of a river. A swampy meadow by a running stream of fresh water is its haunt at Rainham (Essex), but at Brentwood it has been found on a common occupying the highest ground in the district, and at Kingsbury it still exists on a narrow stretch of common land by the roadside. In Owston Woods it occurs in the glades, and in a field outside the wood; at Madeley, in a field of mowing grass, near Walton's Wood, whilst at Abbott's Wood its home is in a marshy meadow surrounded by the wood, and at Enniskillen it haunts the grassy margin of a lake. In Roxburgshire, Elliott finds it flying plentifully in the sunshine, on the grassy bank of a burn side. At Loch Nell, near Oban, it is taken in an open grassy spot in a wood, whilst the Hon. Miss E. Lawless found it very common on the Clare coast, on the same ground as *Anthrocera purpuralis* (*minos*). Atmore obtains it at King's Lynn, by sweeping and searching flowers of *Scabiosa succisa* and *Trifolium pratense*, whilst Borkhausen says that Linné named the insect *statices* because he found the imagines common on flowers of *Statice armeria*.

Time of appearance.—In early seasons this species flies in May. In 1893 it was recorded at Llandogo as early as April 25th, we found it at Chattenden (Kent) on May 20th, 1893, and it was *passé* by May 27th, but June 3rd-10th are the average dates for this locality. In 1888, a late year, the species was out until late in July. Zeller states that in the Glogau Stadwald, on July 31st, 1863, this species was swarming on the flowers of *Armeria vulgaris*, in the burning sunshine. In the same year Zeller had found worn specimens towards the end of June, in the same locality, whilst in other years he had met with specimens as late as August. The same observer records the species at Meseritz, on May 29th, 1869. Chapman found it at Saeterstoen, in fine condition, from June 30th-July 2nd, 1898, and we took it ourselves between April 13th-20th, 1898, at Auribeau, nr. Cannes. Reisen notes it at Warnicken, in July 1877, but near Cranz, in East Prussia, on May 29th-31st, 1882, and Fuchs, as occurring at Oberursel at the end of May, becoming abundant by June 1st. Hofmann says it occurs throughout June and July, in the Upper Harz, and that it flies at dusk with *Hepialus humuli*. Zapater and Korb give it as occurring in July in the Spanish province of Teruel. Lifton writes that, on June 5th, 1896, at Upton St. Leonards, a few specimens only were seen in the early afternoon, but about 5.20 p.m. a swarm appeared to rise from the grass, and hundreds could have been taken. F. H. Day also notices that at Carlisle it flies more freely either at, or shortly before, sunset. We have obtained the following dates:—June 18th-30th, 1856, June 14th, 1859, at Hollingbury Combe (Image), June 2nd-3rd, 1857, at Dorking (Trimen), June 7th, 1857, at West Wickham (Healy), June 9th, 1857, at Acton Fields (Bird), May, 1859, at Loch Nell, nr. Oban (Thomson), June 14th-20th, 1859, at Shorncliffe (Rogers), June 4th, 1860, at Maltby Wood (Batty), July 3rd, 1861, at Worcester (Edmunds), June 2nd, 1864, at Worcester (Horton), May 19th, 1868, at Cirencester (Harmer), June 25th, 1869, at Folkestone (Ullyett), May 29th, fine, June 8th, worn, 1874, at Guernsey (Luff), June 4th, 1883, at Mansfield (Wright), June 10th, 1883, at Ruislip (Melvill), June 14th, 1885, at Cork (Sandford), June 17th, 1887, at Ely (Archer), June 6th, 1888, June 4th-9th, 1889, at Hartley Wintney (Robertson), June 17th-21st, 1889, in Isle of Purbeck (Bankes), June 14th, 1883, June 12th, 1884, June 15th, 1885, June 28th, 1894, June 3rd, 1897, June 6th, 1898, in Guernsey (Lowe), July 2nd-6th, 1885, July 5th, 1886, June 22nd, 1889, June 21st-25th, 1892, July 1st, 1891, at Strensall Common, May 30th, 1895, at Wheatley Wood (Hewett), June 11th, 1887, June 4th-26th, 1890, July 2nd, 1892, May 22nd-27th, 1893, at Chattenden (Tutt), June 15th, 1888, May 31st-June 13th, 1889, June 16th, 1890, at Mill Hill (James), June 22nd, 1887, June 30th, 1891, at Cliffe Hill, June 13th, 1891, at Abbott's Wood (W. E. Nicholson), June 20th, 1885, June 12th, 1886, June 14th, 1887, June 8th-July 29th, 1889, June 20th, 1891, June 4th, 1892, at Chattenden (Fenn), June 8th-July 9th, 1889, July 3rd, 1890, June 22nd, 1891, May 30th, 1893, at Hayton Moss (Routledge), June 19th, 1889, at Brentwood, June 7th, 1895, at Rainham (Burrows), June 8th, 1890, at Calcot, June 18th, 1891, at Wokingham, June 2nd, 1890, June 16th, 1891, worn, at Bramhill, May 27th, 1895, at Degmersfield Park, Odiham (Holland), June 14th-21st, 1891, June 14th, 1892, June 5th, 1896, at Upton St. Leonards, June 13th, 1897, at Painswick (Lifton), June 16th, 1891, at Bramshill (Clarke), May until June 20th, 1891, at Willesden (Adye), June 17th, 1891, June 11th, 1892, June 9th, 1895, at Chattenden (Bristowe), June 4th, 1891, worn, June 11th, 1892, at Epping, June 22nd, 1895, worn, May 29th, 1897, at Broxbourne (Bayne), June 20th, 1891, common, at Grassington (Rowntree), June 2nd, 1892, at Abbott's Wood (Porritt), April 25th, 1893, at Llandogo (Nesbitt), May 19th, 1893, at Enniskillen (Partridge), May 22nd, 1893, at Northwood (South), May 27th, 1893, June 21st, 1894, at Chingford (Prout), May 31st, 1893, at Forest Gate (Mera), May 28th-31st, 1893, worn, June 8th-20th, 1894, at Enniskillen (E. W. Brown), May 13th, 1893, June 2nd, 1894, June 15th, 1895, at Chingford (Bloomfield), May 20th, 1893, abundant, at Surbiton, June 29th, 1898, worn, June 6th, 1896, June 27th, 1897, worn, at Owston, June 6th, 1897, abundant in New Forest (Kaye), June 16th, 1894, in Epping Forest (C. Nicholson), June 28th, 1894, June 10th, 1896, at Legsby, June 27th, 1894, June 15th-18th, 1895, at Linwood, June 2nd, 1896, at Langworth, June 15th, 1896, at Hatton (Raynor), June 8th-20th, 1894, June 10th, 1894, June 28th, 1896, June 27th, 1897, nr. King's Lynn (Glenny), in early July, 1895, on path, at Forest Hill (Helps), June 23rd, 1895, at Loughgilly, nr. Poyntzpass (Johnson), June 15th, 1895, June 20th, 1896, June 27th, 1897, at Owston Wood (Dixon), May 25th, 1896, at Mallow (Newland), June 11th, 1896, nr. Strensall, June 18th, 1897, nr. York (S. Walker), June 11th, 1896, at Sandburn, (Ash), end of May, 1896, nr. Barmouth (Blagg), June 23rd, 1896, worn, at Mill Hill (H. Williams), June 17th, 1897, nr. Harrow (Rothschild), June 12th, 1897, at Carlisle (F. Day), June 22nd, 1897, at Theydon Bois (Garland), July 29th, 1890, at Dursley, worn, June 10th-24th, 1895, June 20th-29th, 1897, at Owston (Bouskell). Prittwitz records it as double-brooded at Brieg, in Silesia, almost certainly an error, although others have made the same suggestion.

Localities.—Argyle: Loch Nell, nr. Oban (*Intell.*, vi., 182), Edlean Righ, Sound of Jura (Vaughan). Berks: Wokingham, Calcot (Holland), Newbury

(Kimber), Reading (Hamm). BUCKS: (Slade), Halton (Stainton). CAMBS: Ely (Archer), Boxworth (Thornhill). CHESHIRE: Delamere (Walker), Knutsford (Harrison). CLARE: Coast district (Lawless). CORK: Bandon, nr. Longfield (Kane), Cork (Sandford), Mallow (Newland), Skibbereen (Wolfe). CUMBERLAND: Keswick (Warne), Cockermouth (Robinson), Hayton Moss, Wreay and Burgh (Routledge), Carlisle (Day), Lake District (Stainton). DERBYSHIRE: Milton (Garneys), Ashbourne, Burton-on-Trent and Stanton (Harris). DEVON: Exeter. DORSET: Hod Hill, nr. Shillingstone (Fowler), Purbeck (Bankes), Dorchester (Stainton). ? DUMFRIESSHIRE. DURHAM: Darlington (Sang), Gibside (Robson), nr. Durham (Wood). ESSEX: Chingford (Bellamy), Theydon Bois (Garland), Epping (Stainton), Brentwood and Rainham (Burrows), Loughton. FERMANAGH: Enniskillen (Partridge). GALWAY: Galway (Kane), Woodlawn (Allen), Ardorhan (Kane). GLAMORGAN: Penllergare and Swansea (Llewelyn). GLOUCESTER: Lower Guiting and Bristol (Stainton), nr. Gloucester (Marsden), Tewkesbury (Fox), Stonehouse (Nash), Cheltenham (Trye), Lydney (Higgs), Cirencester (Harrison), Upton St. Leonards, Newnham and Painswick (Lifton). HANTS: Bramshill, Odiham (Holland), New Forest (Kaye), Basingstoke (Hamm), Ampfield (Hewett), Purbrook (Pierce), Bramsfield (Clarke), Hartley Wintney (Robertson), Lyndhurst (Oakley). HEREFORD: Leominster (Hutchinson). HERTS: Knebworth (Durrant), Hertford (Stephens), Shenley and Broxbourne (Bayne). INVERNESS: Lochaber Loch (Lennon). KENT: West Wickham (Simson), Chatham (Tyrer), Chattenden (Bristowe), Folkestone (Ullyett), Tunbridge Wells (Browne), Shorncliffe (Rogers), Forest Hill (Helps). LANCASHIRE: Crosby and Hale Marsh (Gregson), Chat Moss (Chappell), railway bank nr. Chorley (Hodgkinson), Warrington (Cooke), Preston and Manchester (Stainton). LEICESTER: Gumley (Matthews), Owston (Kaye), Leicester (Stainton). LINCOLN: Pelham Woods (Boult), Hatton, Legsby, Linwood and Langworth (Raynor). MERIONETH: nr. Barmouth (Blagg). MIDDLESEX: Stanmore Common (L. Newman), Enfield and Sewardstone (Edleston), Willesden (Wormald), Acton (Bird), Ruislip (Melvill), Kingsbury (Bond), Headstone Spinney (Rhoades-Smith), Harrow Weald and Pinner (Brown), between Rickmansworth and Northwood, Mill Hill (South), Old Oak Common (Godwin), Harefield (Wall). MONAGHAN: Drumreaske and other places (Kane). ? MORAYSHIRE. MONMOUTH: Wye Valley (Nesbitt). MONTGOMERY: Machynlleth (Alington). NORFOLK: King's Lynn (Atmore), Hemsby, nr. Yarmouth (Pitman). NOTTS: Mansfield (Daws). OXFORD: Oxford (Stainton). ROXBURGH (Elliott). RUTLAND: Uppingham (Bell). SHROPSHIRE: Hampton, nr. Bridgenorth (Harrison). SLIGO: Markree Castle, (Kane). SOMERSET: Weston-super-Mare (Head), Clevedon (Mason). STAFFORD: Leycett Meadows, nr. Madeley (Daltry). SUFFOLK: Mildenhall, Barton Mills, Tuddenham, Needham, Kesgrave, Leiston, Worlingham (Bloomfield), Stowmarket (Stainton). SURREY: Reigate (De Mattos), Surbiton (Kaye), Dorking, Headley Lane (Trimen). SUSSEX: Hollingbury Combe (Image), Bible Bottom, nr. Lewes (Unwin), Hailsham (Fox), Long Meadow, nr. Abbott's Wood (Porritt), Brighton (Stainton), Tilgate Forest (Jenner). WARWICK: Knowle (Bradley), Birmingham (Green), Farnboro (Lifton), Coombe Valley, nr. Rugby (Longstaff). WESTMEATH: Cromlyn (Battersby), Killynon (Kane). WESTMORLAND: Orton (Routledge). WICKLOW: Wicklow (Bristow). WILTS: Marlborough (Maddock). WORCESTER: Wyre Forest (Abbott), Worcester (Horton). YORKS: Grassington and Aysgarth (Rowntree), Barnsley, Doncaster, Leeds, Horsforth, Martin Beck, Snaith, Wakefield and York (Porritt), Sandburn (Ash), Redmire, Wheatley Wood and Strensall Common (Hewett), Kilnsey Crag (Butterfield), Maltby Wood, nr. Sheffield (Batty). The species probably occurs in suitable localities in almost all parts of the British Islands.

DISTRIBUTION.—Asia Minor: The Taurus mts., Gülek (Röber). Persia (North) (Meyrick). Syria: Beyrout (Lederer). Austria: very abundant in Upper Austria (Himsl), Salzburg (Nickerl), Lower Austria, common, Buda, Mehadia, Vienna (Staudinger), Carniola (Scopoli), Patscherkofel, nr. Innsbruck, at 5,000 ft., Heiligenblut at 4,500 ft. (Speyer). Belgium: Brussels (Breyer). Bulgaria: nr. Sofia (Bachmetjew). Channel Islands: Guernsey (Luff). Denmark: general and common (Reuter). France: Fontainebleau (Tutt), nr. Paris, Montmorency (Godart), Depts. of Maas, Moselle, Meurthe, Doubs, Puy-de-Dôme, Savoy (Speyer) Nohant, Sologne, St. Florent, Guéret, Clermont, Royat (Sand), Cannes, Basses-Alpes (Millière), Digne (Staudinger), St.

Martin Lantosque, Burgundy (Constant). Auribeau, nr. Cannes (Tutt). Germany: generally distributed (Kayser). Bavaria (Freyer), Baden (Reutti), Eastern Prussia, common (Halffler), Schwarzwalde at 4,000 ft. (Speyer), Brieg. Silesia, (Assmann), Tannenwald, Nonnenbruch, Hardt, banks of the Wiese, Dorneck (Peyerimhoff), Oberursel in Rhine Valley (Fuchs), Cranz. nr. Konigsberg, Warnicken (Reisen), Upper Hartz (A. Hofmann), Thuringia (Knapp), Pomerania, Stettin (Hering). Greece: Karpinisi, in Attica (Staudinger), Corfu (Erber). Italy: very common in north and central, common in southern, Italy, Italian Tyrol, mountains of Lombardy, Sicily (Curò), Piedmont, Liguria, Tuscany, Naples (Speyer). Netherlands: in most provinces (Snellen). Roumania (Caradja). Russia: generally distributed (Erschoff), Kasan, Orenburg, Saratov (Eversmann), St. Petersburg, Livonia, Caucasus to 6,000 ft. (Speyer). Finland to 64° N. lat. (Reuter), generally distributed in Baltic provinces (Nolcken). Scandinavia: common in southern parts of Sweden and Norway, extending to 62° N. lat. (Reuter), as far north as Helsingland and Oesterbotten (Aurivillius), Ångermanland (Trägårdh), Helleberg (Lampa), Saeterstoen (Chapman), Dovrefjeld, Christiania (Wallengren), Ringerige, Edsberg, Solöer, Hedmarken, etc. (Siebke), Westmannland (Fredrichs), rare in Lapland, Tornea, Upland, Gottland, etc. (Zetterstedt). Spain: Granada (Rambur), Province of Teruel (Zapater and Korb). Switzerland: Basle, Weissbad (Peyerimhoff), Zermatt, Grisons, Upper Engadine (Frey), Tarasp (Killias), Davos (Huguenin), Bergün (Zeller), Canton St. Gallen, Toggenburg, Appenzell (Täschler), Glarus (Heer), Berne, Engstlen, at 5,715 ft., Visp (Jäggi), Schaffhausen (Trapp), Zürich, Winterthur (Biedermann). Bremgarten (Boll), Aargau. Engelberg, Aarau, Lenzburg (Wullschlegel), Lugano (Meyer-Dür), Visp Valley (Jordan).

ADSCITA GERYON, Hübner.

SYNONYMY.—Species: *Geryon*, Hb., "Eur. Schmett.," ii., figs. 130-1 (? 1818); H.-Sch., "Sys. Bearb.," ii., p. 28 (as *statices*, var.) (1845); Led., "Ver. zool.-bot. Ges. Wien," ii., p. 103 (1852); Speyer, "Geog. Verb. Schmett.," p. 358 (1858); Staud., "Stett. Ent. Zeit.," xxiii., p. 354 (1862); "Cat.," p. 45 (1871); Sta. and Staud., "Ent. Ann.," 1864, p. 103; Newm., "Zool.," 1863, pp. 8403 and 8694; "Brit. Moths.," p. 472 (? 1869); Sta., "Ent. Ann.," 1864, p. 122; "Ent. Ann.," 1866, p. 19; Curò, "Bull. Soc. Ent. Ital.," vii., p. 193 (1875); Sand, "Cat. Lép. Auv.," p. 22 (1879); Kirby, "Eur. Butts.," etc., p. 87 (1879); "Cat. Lep. Het.," i., p. 85 (1892); "Handbook," etc., iii., p. 99 (1897); Buckler, "Larvæ," etc., ii., p. 91 (1887); Auriv., "Nord. Fjär.," p. 52 (1888); Hofmn., "Die Gross-Schmett.," p. 33 (1887); "Die Raupen," etc., p. 35 (1893); Barr., "Lep. Brit.," ii., p. 115 (1894); Meyr., "Handbook," etc., p. 449 (1895); Tutt, "Brit. Moths," p. 351 (1896). *Statices*, Ochs. et Treit., "Schmett. Eur.," iv., p. 163, in part (1816); Dup., "Cat. Meth.," p. 53, in part (1844); Speyer, "Stett. Ent. Zeit.," 1859, p. 29; Frey, "Lep. der Schweiz," p. 43, in part (1880). *Chrysocephala*, Nickerl, "Stett. Ent. Zeit.," 1845, p. 93; H.-Sch., "Sys. Bearb.," ii., p. 28 (1845); Freyer, "Neu. Beiträge," v., p. 126 (1845); Led., "Ver. zool-bot. Ges. Wien," ii., p. 102 (1852); Staud., "Stett. Ent. Zeit.," xxiii., p. 356 (1862); Zell., "Stett. Ent. Zeit.," xxxviii., p. 317 (1877), et Auct. *Tenuicornis*, Edmunds, "Ent. Week. Intell.," 1860, p. 196.

DESCRIPTION OF ORIGINAL FIGURES.—Fig. 130.—♂. Fore-wings bronzy-green; hind-wings dark grey; thorax and abdomen green; antennæ pectinated, blunt at tip. Fig. 131.—♀. Fore-wings more bronzy-green than those of male, hind-wings dark grey; thorax and abdomen bronzy; antennæ simple, blunt towards tip (Hübner, *Eur. Schmett.*, ii., figs. 130-131).

IMAGO.—Anterior wings 18 mm.—24 mm. in expanse; bronzy-green in colour. Posterior wings smoky-black; all the wings short and stumpy. The antennæ slightly thickened near the tip, more serrated in the male than in the female. [Much smaller than its British allies, and both sexes of almost equal size.]

Sexual dimorphism.—The sexes are much more nearly equal than in our other British Adscitids. The males average from 22-24 mm., the females about 18·75 mm. in expanse. The smallest males are sometimes only as large as the largest females.

Gynandromorphism. — A specimen of this species is recorded (Slater, *Entom.*, vol. xxix., p. 215) as being captured at Wansford, Northants, on June 1st, 1896, that had the right side with longer wings, and with a pectinated antenna, the left side with shorter wings, and an almost simple antenna.

Variation.—The sexes of this species are very nearly equal in size, although Fuchs mentions that he took among many typical specimens, at Lennig, one as large as *A. statices*. The colour varies from bronze-green to blue-green, the latter form being comparatively rare. The specimens may be classified as: (1) Golden- or bronzy-green (type). (2) Deep green (ab. *viridis*, n. ab.). (3) Blue-green (ab. *caerulea*, n. ab.). Staudinger recognises two local forms of the species:

α. var. *chrysocephala*, Nick.—*Atychia* thorace, abdomine, alisque anticis cæruleo-viridibus, posticis fuscis, antennis valde pectinatis, capite auro-micante. Half the size of *A. statices*. Discovered on high-lying meadows, the Pasterze (Upper Carinthia); inhabits high alps in Carinthia up to 7,000 ft., common nr. Salzburg (*Stett. Ent. Zeit.*, 1845, p. 93).

This has always been looked upon as a mountain insect, and by many Continental authors considered a distinct species from *A. geryon*, by others as a mountain form of *A. statices*. Staudinger notes it in his *Cat.* p. 45, as "var. minor; highest Alps of Carinthia and Switzerland." Speyer considers it as an alpine or subalpine insect, and gives as localities Heiligenblut, 5,500-8,000 ft.; Andermatt, 4,500 ft.; Mürren, 5,000-5,500 ft. Zeller says, it appears in late June-July, and at moderate elevations in August; he found it abundantly at Siala, and in the meadows between Latsch and Stulo. Frey, who considered it as a mountain form of *A. statices*, says that the name was given in error, a red-headed specimen never being seen in nature, and notes it as occurring in the high alps of the Engadine, and at Zermatt, at 8,000 ft. and over. Curò notes it from the Italian Alps, and Reutti from Nassau, whilst Fedtschenko records it from Naubid, in Central Asia, between 4,500-8,000 ft., on June 9th. The only difference there may be between the mountain and lowland forms is the slightly smaller size of the former, but even this is doubtful in a long series.

β. ? var. *anceps*, Staud.—Of the same size as *A. geryon*, but its antennæ decidedly longer and somewhat stouter. The fore-wings are much more densely scaled, very shiny, green, with golden gloss. The hind-wings less transparent, blacker. The black inner marginal angle is also, in most examples, very strongly developed. The two females not smaller than the males (*Stett. Ent. Zeit.*, xxiii., p. 355).

Staudinger notes that he has this form only from Brussa, and is inclined to consider it distinct from *A. geryon*. Lederer remarks that he once received from Brussa a consignment of *A. geryon*, which may have been the insect in question. On the other hand, other specimens were referred by Lederer to *obscura*, Zell., although (*teste* Staudinger) some only were dull examples, and others shiny green like the *anceps*, described above. It may be that Lederer's *obscura* were, in part, *anceps*, Staud.

COMPARISON OF A. GERYON AND A. STATICES.—*A. geryon* is much less than *A. statices*, the two sexes of the former being much more nearly of the same size than are those of the latter. Compared with those of *A. statices*, the antennæ of *A. geryon* are shorter and stouter in the male; the fore-wings green, more or less glossed with gold, rarely blue. The hind-wings are more transparent than those of *A. statices*, and so appear somewhat blacker.

EGG.—The eggs are sometimes deposited singly, but more often in little patches of five or six, placed generally side by side in two rows. The egg is, according to Buckler, "just like that of *A. statices*, but, perhaps, a trifle smaller; it is also yellow in colour." Chapman states, however, that the egg of *A. geryon* is larger than those of *A. statices* and *R. globulariae*. Hellins says that eggs laid between July 1st-5th began to hatch on July 15th. Horton had eggs laid on June 17th, 1864, these hatched on July 20th.

HABITS OF LARVA.—The larva hatches during July, and feeds on rock-rose (*Helianthemum vulgare*), gnawing at first the surface of a flower-bud or leaf. It then burrows into the leaf, and eats out a little blotch, although the larva never seems to insert more than half of its body into its burrow. This mining habit of the young larva was first discovered by Horton in 1864. When about a month old the larvæ eat away patches from the underside of the leaves, leaving the upper skin untouched. The hybernated larva may be found in May on *Helianthemum*. The full-grown larvæ eat the whole substance of a leaf, or even the tender stem of a twig, and, like *A. statices*, this species feeds best in the sunshine. A larva which Hellins tried with sorrel refused to eat. Edmunds found larvæ, pupæ (about 100), and imagines on May 22nd, 1863, the larvæ on *Helianthemum*; these also refused sorrel. Horton records finding *A. geryon* as larva, pupa and imago on the same day (May 18th, 1864). The larvæ are usually full-fed in May (sometimes in April). Buckler notes them as commencing to spin May 2nd, 1863, whilst larvæ sent to him on April 19th, and May 10th, 1886, began to make their cocoons towards the end of May, although three did not do so until June 25th. Horton could see no difference between the eggs and young larvæ of *A. geryon* and *A. statices*, but the larvæ of the former would not eat sorrel (*Rumex acetosa*) nor those of the latter, *Helianthemum*. Newman's statement (*Zool.*, xxi., p. 8694), that, not having *Helianthemum*, he "gave the larvæ *Rumex acetosella*, on which they arrived at maturity," therefore, requires confirmation, especially as in *Brit. Moths*, p. 472, he contradicts this statement, and says "that the food-plants of *A. statices* and *A. geryon* are totally different, that of the common Forester (*A. statices*) being *R. acetosella*." Nicholson found the larva of *A. geryon* in the Coombe (Lewes) on May 13th, 1885; it commenced to spin on May 25th.

LARVA.—We are indebted to Chapman for our knowledge of the structure of the *newly-hatched* larva. Each segment has trapezoidal tubercles (i, ii), with hairs having globular, jointed bases. As in the larva of *R. globulariae*, the trapezoidals on either side are conjoined, to some extent, into one tubercle, though the hairs are distinct. The tubercles are also, even, united somewhat by a slightly raised base, with those of the opposite side. Although the spines representing the anterior and posterior trapezoidals are close together on each side, those of the one side are widely separated from those on the other. There are also a supraspiracular and a subspiracular tubercle on each segment, each with a simple spine. The dorsal hairs of the prothoracic and mesothoracic segments are without globules, but on the metathorax the hair in line with the supraspiracular tubercles has a globule. There is another simple hair beneath this, and another lower down in line with the spiracles. The prolegs have 3-4 hooks (usual number 4). The anal plate is very finely spinous. The hairs of the anterior trapezoidals bear 10 rings of very fine spines, those of the posterior, 10 or 11, whilst those of the supraspiracular tubercles have 18 similar rings of minute spines. Hellins says that the *newly-hatched* larva is just over 1 mm. in length, very stumpy, yellow, with small black head. The trapezoidals are combined in two large transverse tubercles, each tubercular dot bearing one bristle. When five weeks old the larvæ are about 3 mm. long, their tubercles set with fascicles of short bristles, the larger individuals having an edging of dull purplish to the dirty whitish dorsal area, whilst the skin around the tubercles is set with tiny black points. At three months old they are 5 mm. long, very plump, the back quite white; the dorsal tubercles slightly brownish, a distinct double dorsal line of a dull claret colour, the scalloped line which borders the back deep purplish, the large lateral warts, dull claret-coloured, bordered below with a whitish line, then comes a deeper claret line, then another whitish line, and the two lower rows of tubercles are brownish-pink. After hybernation the larvæ grow at very different rates, some becoming full-grown much more rapidly than others. The *full-grown* larva is about 12 mm. long, somewhat fusiform, being stoutest at the abdominal segments 5 and 6. The head glossy-black, small, retractile into the prothorax, which is smaller than the remaining segments. The segmental incisions well marked. On the mesothorax, metathorax, and the first eight abdominal segments are eight rows of large raised tubercles, those on the back being elongated transversely; all are set with fine short bristles; the skin between is set with tiny hard stellate dots with five or six points, but these do not extend below the spiracles. The prothorax has a blackish dorsal plate with a yellowish edge in front. The dorsal tubercles are either dingy white or pale yellow, with a double dorsal line of purplish-brown enclosing a whitish thread. The back is bordered with a claret-coloured wavy line, below which comes a wide reddish-brown stripe, bearing the row of large lateral tubercles of the same colour, but narrowly outlined with pale flesh-colour. This reddish-brown stripe extends to just below the spiracles, which are of the same colour, round, and finely ringed with black; next comes a stripe of pale flesh colour, bearing a row of tubercles of the same colour, but outlined with brown, then a stripe of brown, then the lowest row of tubercles of paler brown. The ventral area is of a dingy flesh-colour, the true legs with blackish rings, the prolegs yellowish; the bristles dirty whitish with blackish tips.

Cocoon.—The cocoon is generally spun low down among moss at the roots of the food-plant, sometimes attached to the stem of the latter. It is a tough, webby structure (not stout or papery in texture), somewhat fusiform in shape, about 12 mm. long, and 5 mm. at its widest part.

In colour it is of a dirty grey, with a slight yellowish tinge. Gardner says the cocoon is white, and spun amongst moss at the roots of the food-plant. Edmunds found above 100 cocoons on May 22nd, 1863, spun up among *Hypnum triquetrum*, and remarks that they were attached only to moderately grown plants of this moss, neither the very long nor very short moss giving any cocoons.

PUPA.—The pupa of *A. geryon* is described by Hellins as being about 9 mm. long, fusiform, the head small, the abdomen plump, the eye- and antenna-cases well-developed, the wing-cases long and free at the edge, the tongue-case reaching nearly to the anal segment, and free beyond the edge of the wing-cases, with one pair of legs parallel, nearly as long, and also free; the anal segment rounded. A transverse row of small points on the front edge of the back of each of the abdominal segments. The colour of a deep shining olive on the wings and head, the abdomen being more bronzy.

PARASITES.—*Apanteles geryonis*, Marshall, bred by Messrs. Hutchinson and J. E. Robson, *Limneria fulviventris*, Gmelin, and *Apanteles nothus*, Reinhard (Bignell).

FOOD-PLANTS.—*Helianthemum vulgare* (Weir, Hellins), *H. chamaecistus* (Aurivillius). [Newman gives *Rumex acetosella*, but Edmunds, Horton and Hellins deny this as a food-plant.]

HABITS AND HABITAT.—The species was introduced into the British lists as *Procris tenuicornis* in 1859, by Edmunds, who took specimens in Worcestershire, flying on limestone ridges (*Intell.*, vol. vii., p. 196). Doubleday then received specimens from Brighton resembling *P. tenuicornis* from Dalmatia, but Guenée referred these to the *A. geryon* of Hübner (*A. chrysocephala* of later authors). The Brighton and Worcester specimens were considered to be identical (*Intell.*, vol. viii., pp. 21-22), and the distinction of the species from *A. statices* was determined by Edmunds and Horton, who discovered the larva on the Malvern Hills. On the Continent it is generally considered a mountain species, and is generally known from the higher Alps, under the name of *chrysocephala*, but it also occurs at lower levels (in the Rhine Valley, in dry places near Vienna, etc.). The fact is, the species appears to be confined to chalk and limestone districts where its food-plant grows, and, where suitable spots occur, the elevation matters little. Thus it occurs at low levels in the Rhine valley as with us, but owing to most of the entomologically best known limestone districts on the continent being among the mountains, it has become better known from these districts than elsewhere. In Sussex, near Lewes, *A. geryon* frequents a dry sunny bank on the downs, facing due south, with extensive patches of *Helianthemum vulgare*, on which the larva has been found (W. E. Nicholson); near Winchester, on the side of a hill, on the banks bounding a large hollow known as the Devil's Punch Bowl (Broome). It occurs over a wide range of the Cotswolds, being especially abundant about five miles from Gloucester; some years (1896) it is abundant, in others (1897) comparatively rare (Merrin). At Dursley, the males fly among the long grass in hundreds, the females hide among the grass (Griffiths); on the open downs of the Cotswolds (Todd); above Gloucester (on the Cotswolds) it flies in a woodland glade, about 700 ft. above the sea, on the Inferior Oolite formation, and on the hills above the Stad Valley, in an upland ancient lane (Watkins). Along the hills lying between Painswick and Cooper's Hill, round to Birdlip, it occurs in grassy spots, whilst the hairy larvæ have been captured in numbers at the back of the Royal William Inn, at Cranham (Merrin). In the Derbyshire dales, it loves the slopes of the limestone valleys, flying slowly in the sun, and settling on flowers (Sheldon). At Witherslack it occurs on the grassy slopes of a limestone hillside; around Chinnor, in the glades of the beech woods; whilst on the long outcrop of the Carboniferous limestone, running from Llanymynach, in Shropshire, through Denbighshire and Flintshire, to the Great Orme's Head, the insect occurs in favourable places. Around Bakewell it abounds in some of the dales. In Durham it is found on the coast, beginning about three miles north of Hartlepool, and extending for a considerable distance. At Castle Eden it occurs on rough grassy cliffs, whilst at Sledmere and Richmond it is found on rough banks near the woods. The limestone habitat extends to the Continent, for Lederer notes it as occurring on the limestone hills between Mödling and Baden, on *Centaurea* and thistles. Near Lennig, in the Rhine Valley, it occurs in a wood clearing, basking on flowers in the sun (Fuchs). Zeller has found it in the meadows of the Ober-Albula; Frey, at Zermatt, at 8,000 ft., and we have taken it on blossoms, at considerable elevations above Courmayeur, Cogne, Le Lautaret, and other alpine localities.

TIME OF APPEARANCE.—Varies according to the season, somewhat similarly to *A. statices*. Robson, however, notes it as regular in its time of appearance in Durham, and varying but little in abundance from year to year; June, at Richmond, Yorkshire (Hewett), June and July, on the Castle Eden coast, and July, at Sledmere (Maddison), beginning of July, at Folkestone (Vaughan). Abroad, Fuchs notes July 19th-22nd, 1875, worn, and July 5th-17th, 1876, nr. Lennig, in the Rhine Valley; Zeller says from mid-May to July 1st, in the Grisons, and from July 1st till August, in the Latscher meadows of the Ober-Albula; Stainton notes it on July 13th, 1865, in the Val de Fain, in the Engadine. We took it from August 9th-13th, 1898, at Courmayeur, and Zapater and Korb record it in July and August, in the Spanish province of Teruel. Other dates for the imagines are: June 18th-30th, 1856, June 14th, 1859, at Hollingbury Coombe (Image), June 19th, 1858, nr. Brighton (Beauchamp), May 22nd, 1863, larvæ, pupæ and imagines on the same day, nr. Worcester (Edmunds), July 19th, 1863 (bred) (Buckler), May 18th, 1864, nr. Worcester (Horton), June 3rd, 1865, June 14th, 1867, at Witherslack (Hodgkinson), May 24th, 1866, at Malvern, May 24th, 1867, on the Cotswolds (Todd), May, 1869, on Cotswolds, nr. Gloucester (Marsden), June 7th, 1869, on Cotswolds (Merrin), June 16th, 1870, June 15th, 1871, nr. Lewes (Jenner), July 19th, 1879, at Folkestone (Wellman), June 25th, 1879, at Castle Moreton (Fox), June 10th, 1879, at Barmouth (Goss), June 5th, 1880, June 6th, 1881, May 29th, 1882, May 29th, 1883, at Pegsdon Hills, nr. Hitchin (Durrant), June 15th, 1885, at Lathkill Dale (Sheldon), June 22nd, 27th, 29th, 1886 (bred) (Hellins), June 14th, 1890, June 18th, 1891, May 22nd, 1893, June 3rd, 1895, May 24th, 1896, at Aylesbury (Bayne), June 20th, 1890, at Keswick (Barclay), June 25th, 1890, June 13th, 1897, at Painswick, May 21st, 1894, May 13th, 1896, at Harefield (Lifton), June 16th-25th, 1891, May 31st, 1893, worn, June 16th, 1896, worn, nr. Lewes

(W. E. Nicholson), June 6th, 1892, at Dursley (Griffiths), June 8th, 1892, May 23rd, 1893, June 12th, 1894, June 3rd, 1896, at Monsal Dale, June 26th, 1897, at Miller's Dale (Fuller), May 24th-June 6th, 1892, May 9th-22nd, 1893, June 3rd, 1895, May 26th, 1896, June 8th, 1897, at Dursley (Bartlett), July 2nd, 1893, July 7th, 1894, abundant and fine, at Horden Dene (Brady), June 8th, 1895, nr. Winchester (Broome), May 28th, 1896, at Witherslack, end of May, 1896, at Hamps Fell (Crabtree), June 1st, 1896, at Wansford (Slater), June 4th, 1897, on the Cotswolds (Todd), June 22nd, 1897, at Sledmere (Walker).

Localities.—Berks: Sandhurst (Bacon). Bucks: Aylesbury (Bayne), Tring (Rothschild). Cumberland: Keswick (Barclay). Derby: Lathkill Dale (Sheldon), Longstone Edge, Monsal Dale, Cressbrook Dale and Miller's Dale (Fuller), Middleton Dale (Alderson), Bakewell (Thornewill). Durham: Castle Eden coast (Maddison), Durham (Knaggs), Blackhalls (Merryweather), Horden Dene (Brady), Hartlepool (Robson). Gloucester: Bristol and Dursley (Griffiths), Stroud (Wainwright), nr. Tewkesbury (Fox), Harefield (Lifton), Broadway Beacon, nr. Cheltenham (D'Orville), Cotswolds, nr. Gloucester (Marsden), Stad Valley, Edge Hill and Painswick (Watkins), Stonehouse (Nash), Gloucester (Merrin). Hants: Winchester (G. M. A. Hewett). Herefordshire: Hereford (Blathwayt). Herts: Pegsdon Hills, nr. Hitchin (Durrant). Kent: Folkestone (Vaughan, Ullyett queries the species), Canterbury (Knaggs), Shorncliffe (Vaughan). Lancashire: ? Manchester (Knaggs), Hamps Fell (Crabtree), Grange (Hodgkinson), Silverdale (Melville). Merioneth: Barmouth (Goss). Northampton: Wansford (Slater). Oxford: Chinnor (Spiller). Someset: Bath (Greer), Clevedon (Mason). Staffs: Dovedale (Bostock). Sussex: Lewes (Weir), the Coombe and Cliffe Hill (Nicholson), Hollingbury (Jenner), Brighton (Knaggs). Westmorland: Witherslack (Crabtree). Wilts: Marlborough (Maddock). Worcestershire: Malvern (Todd), Lower Wick (Horton), Malvern Hills, nr. Worcester (Edmunds). Yorks: Beverley, Muker, Richmond, Sheffield, Thorne, York and Sledmere (Porritt).

Distribution.—Asia Minor: Brussa (Lederer). Syria (Speyer). Turkestan (Meyrick). Central Asia: Naubid (Fedchenko). Austria: Galicia (Garbowski), Vienna (Doubleday), chalk-hills between Mödling and Baden (Speyer), Heiligenblut, from 5,500-8,000 ft. (Staudinger), Salzburg Alps, from 6-7,000 ft. (Herrich-Schäffer), Hungary (Constant, coll.). France: Autun, St. Martin Lantosque, Burgundy (Constant), Pyrenees (Guenée), Mont Dore (Sand), Dauphiny Alps, Le Lautaret (Tutt). Germany: south-east Germany, Silesia (Lederer), Gotha, Laucha Wood (Knapp), Lennig, in Rhine Valley (Fuchs), Nassau, Ueberlingen, Waldshut, Kaiserstuhl, Weinheim (Reutti). Greece: Corfu (Erber). Italy: Alps (Curò), Lauson, Cogne Valley, Courmayeur (Tutt). Roumania: Grumazesti (Caradja), Tultscha (Mann). Scandinavia: Lillehammer (Champion), Blekinge (Wallengren). Spain: Pyrenees (Staudinger), Province of Teruel (Zapater and Korb). Switzerland: Visp Valley (Jordan), Andermatt, at 4,500 ft., Mürren, from 5,000-5,500 ft. (Speyer), Engadine (Nicholson), Grisons, Ober-Albula (Zeller), nr. Simplon (Jordis), Zermatt, 8,000 ft. and over (Frey).

Genus: RHAGADES, Wallengren.

Synonymy.—Genus: *Rhagades*, Wallgrn., "Scand. Het.-Fjär.," p. 110 (1863); Auriv., "Nord. Fjär.," p. 51 (1888). *Sphinx*, Hb., "Eur. Schmett.," p. 76 (? 1805). *Atychia*, Ochs., "Schmett. Eur.," ii., p. 10 (1808). *Procris*, Auct. *Ino*, Auct.

The diagnosis of this genus by Wallengren reads (*Scand. Het. Fjär.*, p. 110), as follows:—

Rhagades, n. gen.—Antennæ fusiformes, maris usque in apicem pectinatæ, feminæ serratæ, apice tenui, acuto. Palpi brevissimi, gracillimi, obtusi. Lingua mollis, brevis, pectore multo brevior. Oculi nudi. Calcaria pedum posticorum 2, Ramulus carpalis costæ medianæ anterioris alarum anticarum simplex; ramulus sesamoideus ejusdem costæ adest; ramulus glenoidalis costæ medianæ postioris semper adest. Costa subcostalis alarum posticarum, radice duplici e basi oriens, contagione cum costa mediana anteriore connexa, ut areolam subcostalem clausam formet. Costa mediana anterior al. posticarum erga basin distincte subtilior. Abdomen gracilior, squamatum, maris saltem plerumque ad latera pilosulus, alis expansis nonnihil longius. Alae anteriores subrotundatæ. Larva subdialis crassa, capite minuto, pilis fasciculatis obsita, subdepressa, dorso squamulato. Pupa cylindrico-conica, folliculata; folliculum membranaceum.

The typical species of the genus, as named by Wallengren, is *Rhagades pruni*. The following characters appear to distinguish *Rhagades (globulariae)* as compared with *Adscita (statices* and *geryon)*; undoubtedly, close study would result in the discovery of others:

Larva.—The hair on tubercle i with bulbed base (on ii simple) in first skin.

Imago.—Antennæ pectinated, with apex somewhat acute. *Body* more slender than in *Adscita*.

RHAGADES GLOBULARIÆ, Hübner.

Synonymy.—Species: *Globulariae*, Hb., "Eur. Schmett.," ii., pl. i., figs 2 ♂, 3 ♀, ? pl. i. bis, fig. 4 (? 1797), p. 76 (? 1805); Ochs., "Schmett. Eur.," ii., p. 13 (1808); "Godt., "Lép. France," iii., p. 160 (1821); Stphs., "Illus.," i., p. 106 (1828); Freyer, "Neue. Beitr.," i., p. 119, pl. 62, fig. 2 (1833); Evers., "Faun. Lep. Volg.-Ural.," p. 91 (1844); Dup., "Cat. Meth.," p. 53 (1844); Weir, "Zool.," 1845, p. 1085; Assmann, "Abbild. und Besch. Schmett. Schles.," p. 5 (1845); Zell., "Zeits. Ent. Ver. Bres.," 1850, pp. 31-32; 1853, p. 83; Led., "Ver. zool-bot. Ges. Wien," v., p. 104 (1852); Sta., "Ent. Ann.," 1855, p. 27; "Man.," i., p. 178 (1857); Speyer, "Geog. Verb. Schmett.," p. 359 (1858); Hein., "Die Schmett. Deutsch.," p. 154 (1859); Staud., "Stett. Ent. Zeit.," xxxiii., p. 349 (1862); "Cat.," p. 44 (1871); Sta. and Staud., "Ent. Ann.," 1864, p. 102; Sta. and Zell., "Ent. Ann.," 1864, pp. 103-107; Knaggs, "Ent. Ann.," 1864, p. 122; Mill., "Cat. Lép. Alp.-Mar.," p. 124 (1872); Curò, "Bull. Soc. Ent. Ital.," vii., p. 193 (1875); Sand, "Cat. Lép. Auv.," p. 21 (1879); Kirby, "Eur. Butts.," etc., p. 86 (1879); "Cat. Lep. Het.," i., p. 83 (1892); "Handbook," etc., p. 100 (1897); Peyer., "Cat. Lep. Als.," p. 46 (1880); Frey, "Lep. der Schweiz," p. 63 (1880); Buckler, "Larvæ," etc., ii., p. 1 (1887); Hofmn., "Die Gross-Schmett.," etc., p. 33 (1887); "Die Raupen," etc., p. 35 (1893); Auriv., "Nord. Fjär.," p. 51 (1888); Barr., "Lep. Brit.," ii., p. 109 (1894); Meyr., "Handbook," etc., p. 450 (1895); Tutt, "Brit. Moths," p. 351 (1896).

Description of original figures and original description.—Fig. 2.—♂. Fore-wings distinctly green (not blue or golden), with dark greyish fringes; hind-wings blackish-grey. Antennæ pectinated, pointed towards tip. Thorax and abdomen green. Fig. 3.—♀. Much smaller than male; base of fore-wings green, outer half bronzy; hind-wings blackish-grey. Antennæ almost simple (Hübner, *Eur. Schmett.*, pl. i., figs. 2-3). Kugelblumenschwärmer: *Sphinx globulariae*, fig. 2 ♂, 3 ♀. Gänzlich hell, lahnglänzend, gelbgrün, nur die Unterflügel oben, sammt ihren Franzen, hellgrau, unmerklich grünschillernd; unter beiderlei Flügel grau, blos von ihrer Wurzel aus etwas grün beschuppt. Heim. Deutschland, auf Heiden (Hübner, *Sammlung Europ. Schmett.*, p. 76). [This description was probably published much later than the figures.] Hübner then goes on to say: "The species is more slenderly built than *S. statices*, the antennæ longer, apex pointed, the wings in male broader, and in female smaller. The colour varies slightly towards blue-green" (*Ibid.*, p. 76).

Imago.—Anterior wings 20-29·5 mm. in expanse; golden-green. Posterior wings smoky-grey, almost blackish; antennæ weakly pectinated, somewhat pointed at the tip. [The fore-wings are distinctly broader than those of *A. statices*.]

Sexual dimorphism.—The males average from 28-29·3 mm., the females 20-21 mm.; the antennæ of the females are more slender, and the abdomen much stouter, than those of the males.

Variation.—In both sexes there is a distinct dimorphism in colour, some males and females being of a golden-bronze (type form), others of a bright green (=ab. *viridis*, n. ab.), this colour dimorphism being noted by Staudinger, also, in var. *notata*. This is independent of the change in tint observed when the specimens are looked at sideways, under which conditions they become a much deeper, and somewhat bluish, green. Hübner evidently knew both forms. His colour description "gelbgrün," and his fig. 3, ♀, lead us to suggest the more golden-green as the type form, although his fig. 2 ♂ is the ab. *viridis*. We once met, at Le Lautaret, 7,500′ elevation, with a race having delicate blue fore-wings in both sexes, with typical antennæ and hind-wings, and slender abdomen; the males 34 mm. and the females 18 mm. in expanse. This we would call var. *caerulea*, n. var. The following doubtful vars. of this species may also be noticed:

α. ? var. *notata*, Zell.—Alis anterioribus viridi-cœruleis, subobtusis, postice dilatatis, fem. breviusculis; posterioribus fumatis, plica longitudinali cœruleo-squamata, antennis acutis, maris brevius biseriato-pectinatis, fem. longioribus filiformibus apice attenuatis. Sicily: Syracuse. April 21st-May 6th (Zeller, *Isis*, 1847, p. 294).

Staudinger notes (*Stett. Ent. Zeit.*, xxiii., p. 351) that he has three of Zeller's original specimens from Syracuse, which agree with 8 Andalusian examples (from Ronda, Granada, Chiclana and Malaga), 9 from northern Greece, and 3 from France (2 ? from Paris, and 1 from Saone-et-Loire). This form has a decidedly finer antennal shaft, shorter pectinations, which also lie close to one another. The fore-wings are more distinctly shining, most specimens with a decided golden tint, other specimens, however, are almost entirely without it. He further expresses (*Horae Soc. Ent. Ross.*, 1870, p. 171), when discussing Greek specimens taken nr. Karpinisi in middle June, great doubt as to whether *notata* should be considered a distinct species or a variety of *R. globulariae*, which undoubtedly varies much. He says: "According to the finer antennal pectinations, it should be considered specifically distinct, but it is now doubtful to me whether these, in all cases, give a specific character." In the *Cat.*, p. 44, Staudinger writes of it: "Antennis ♂ brevius pectinatis, perhaps a distinct species; from Spain, Italy, Greece, South and Central France," and gives *soror*, Rambur, from Granada, and *cognata*, Luc., from Algeria, as synonyms. Specimens bearing this latter name in Constant's collection looked much like pale *R. globulariae*. Kirby treats *notata* as a distinct species. If this be simply a local blue-green race of *R. globulariae*, it can only occur as a very rare aberration in this country. Staudinger's extension of the var. to include *cognata*, Luc., appears to go beyond Zeller's diagnosis.

β. ? var. *cognata*, Lucas, "Explor. Sci. Algéria," iii., p. 373, pl. iii., fig. 2 (1849).—Long. 30 à 33 mm. *Procris* alis anticis, capite, thorace abdomineque viridi auratis, primis infrà secundisque cinerescentibus atque cinerescente fimbriatis; antennis elongatis, exilibus, viridi durato subcyaneo tinctis dentibusque fuscis, pedibus elongatis, femoribus viridi atratis, tibiis tarsisque cinerescentibus.

The figure is pale, bright green, with pale grey hind-wings, pectinated antennæ with pointed apices; it is brighter and paler than British *globulariae*. Lucas says that it is larger than *A. statices* which it much resembles; the anterior wings, thorax and abdomen, golden-green, brighter than *A. statices*; the posterior wings of a paler ashy colour; the fringes very pale ashy colour (not golden-green, as in *A. statices*). The antennæ elongated, much thinner than the French species, the antennal shaft light greenish-blue, with the pectinations very dark brown, and much less serrated than in *A. statices*. From the neighbourhood of Constantine, in May, etc. Staudinger queries (*Cat.*, p. 44) this as being identical with *soror*, Ramb., *Cat. Lép. And.*, p. 187 (1866), which came from Granada, and is diagnosed as "viridi-aenea vel cuprea; antennis gracilibus, dentibus brevioribus," and is said to differ from *R. globulariae* in the more slender antennæ, of which the more pointed pectinations are only half as long. Staudinger is inclined to consider it as identical with var. *notata*, Zeller.

γ. ? var. *incerta*, Staud., "Stett. Ent. Zeit.," xlviii., p. 72 (1887).—Size 20-25 mm. The pectinations lie close together, so that they appear very thin. The antennæ of the ♀ are scarcely serrated (at least less so than in *R. globulariae*). The fore-wings are blunter and darker green than the very glossy tint of *R. globulariae*, and similar to that of *R. solana*. A single female (from Margelan) is almost blue-green, with more gloss than usual. The black-green fringes contrast moderately with the green wings. The hind-wings are transparent-black, as in *R. globulariae*, and on the underside they are sometimes (especially in the Margelan specimens) rather strongly tinged with green. The fore-wings beneath are without any green-blue tinge. The head, thorax, and ventral side of abdomen are of a rather glossy green tint, the latter, above black, tinged with green.

Staudinger notes this insect in "some numbers from Margelan and Namangan, also a single individual from the Alexander mountains, and thinks it may be, perhaps, only a very small form of *R. globulariae*, as it has almost the same form of antennæ." But he further states that "this much smaller *incerta*, in spite of its almost identical antennal form, looks so different from *R. globulariae* (more especially from its much blunter fore-wings), that I cannot consider it a local form thereof, although that is possible. On the other hand, the insect appears so similar to large *R. solana*, that I can only distinguish them by the antennæ, which appear much thinner in *incerta*, and probably are so; the antennæ of ♀ *solana* are also more serrate than those of *incerta*. As I have received both insects from Margelan and Namangan in some numbers, and can pretty readily separate them by the antennæ, I am inclined to think they are distinct species."

Egg.—The egg of *R. globulariae* is, according to Buckler, of a long-oval shape, about $\frac{1}{40}''$ long, and $\frac{1}{70}''$ wide, having at first a depression on some part of the surface, and adhering lengthways to the substance whereon laid, singly, or sometimes two or three together. The shell is very finely ribbed, and of a deep yellow colour, which changes a few hours before hatching to a dull pinkish, or to a light brownish tint, showing a deeper brown spot at one end, and by that time the egg has become very plump.

Habits of larva.—The *young larva* leaves the egg about the middle of July. It is a small yellow mite, and is very active until it meets a suitable spot on a leaf, when it at once begins to mine, boring into a leaf of *Centaurea nigra*, embedding itself in the substance, and forming a semi-transparent spot, which is afterwards enlarged into a small blotch between the upper and under epidermis of the leaf, excavating the leaf almost to the tip. When necessary the larva leaves one leaf and enters another, the vacated blotches, where the parenchyma has been eaten out, becoming somewhat conspicuous. The first moult occupies nine days, according to Buckler, and the three succeeding moults follow after about four days feeding and nine days of rest on each occasion, the larva leaving its mine and spinning a silken web, on which it rests whilst the operation is performed. When mining, the larva throws out black frass from its mine. It feeds a little after the fourth moult, before hybernation, which it commences early in October, leaving its large blister-like mine, spinning a silken mat, and passing a few silken threads over its back to support it on the underside of a leaf. The larva commences to feed again early in February, and it continues to do so throughout March and April, mining into the leaves. It moults again at the commencement of May, and again towards the end of May, making large blotches in the *Centaurea* leaves, sometimes abstracting nearly the whole of the parenchyma of the leaf. When full-fed (about the end of May or beginning of June), the larva is said to remain for three or four days on the surface of the ground, which it then enters for pupation. Buckler notes full-fed larvæ from May 30th-June 2nd, 1883.

Larva.—When the *newly-hatched* larva leaves the egg it is short and stumpy, with a small, black, shiny, retractile head, the prothorax with a glossy brownish corneous plate, having a broad, black, dotted streak, tapering to a point at the front and a black streak on each side. The remaining segments are greenish-drab, and covered with a short, white pubescence. After the *first moult* it is of a light green colour, and the tubercles bear stiff bristles (Buckler calls the larva "a mass of bristly tubercles"), but it becomes somewhat buff-coloured before moulting. After the *second moult* it is still greener, becoming deep flesh-colour before moulting again. After the *third moult* it is dark slaty-green, the colour matching well with that of the leaves of the food-plant, whilst a thin, dingy, purplish-brown, longitudinal, dorsal line, spreading a little at each segmental division, runs between the rows of dorsal tubercles. The tubercles are covered with short radiating bristles of a drab colour, but before it moults again it becomes much lighter, and is of an ochreous-green hue. After its *fourth moult*, when fixed for hybernation, Buckler compares the shape of the larva with that of a small hemp-seed, and says that there are three rows of bristly, oval tubercles on either side of the body, running in a longitudinal direction, so that six tubercles surround each segment, except on the venter, which is naked, whilst between the two which occupy the back of each segment is a black arrow-head mark. The dorsal tubercles are dark, dingy, brownish-green, with yellowish-green outer edges, relieved by a fine blackish line beneath. After hybernation, the larva appears almost black, but, after feeding, it becomes greener. After the next moult the tubercles become bluish-green, the dorsal ones being strikingly defined by a creamy-white sub-dorsal stripe, below which is a wider stripe of dark green. After the last moult, when the larva is *full-grown*, it is described by Buckler as measuring, when stretched out, from 13-14 mm. in length, the greatest width, across the middle of the body, 5 mm. It tapers a little at either end, and is rounded off behind, and also in front, when at rest, with the first two segments retracted. The head is extremely small and flattened, the segments are plump and very deeply divided, the prothorax is smooth and glossy, the tubercles are slightly raised, large, occupying nearly the length of a segment, except the lowest (placed just above the feet), which are rather smaller; in shape, they are roundish ovate, the dorsal pair, side by side on each segment, are set close and obliquely together in front, leaving between them a small arrow-head-like space behind at the division. The prolegs are rather short, and placed well under the body; the belly is flattened and smooth. In colour the head is black, the antennal papillæ greenish-white tipped with black, the prothoracic segment greenish, with a broad black marking or plate tapering towards the front, the tubercles on the back are of a rather bluish-green tint, the dorsal row of markings black, the white subdorsal marking inclines to creamy-white, sometimes to yellowish-white, this is contrasted strongly below by a broadish stripe of dark green tapering towards the head and a little also to the hinder part of the body; on the smooth skin, between the dorsal tubercles at the beginning of each segment and of the white subdorsal marking, are sprinkled some most minute black dots, only a few on the white where it is broadest, but they are numerous on the dark green stripe following it; the side below is entirely green, including the tubercles, and the whole of them are studded thickly with short and fine blackish bristles: the spiracles are black, true legs black, the ventral prolegs green." We are indebted to Chapman for a more exact knowledge of the structure of the larva. He describes the *newly-hatched larva* as being rather square and truncate at either end. It has a blackish-brown head and large prothoracic plate, then a dorsal elevation of each segment, more pronounced on either side, consisting of two dorsal tubercles (i and ii) conjoined in the middle line. It might, indeed, be said that the tubercles are separate in the middle line, but the elevation hardly sinks completely; each tubercle carries an inner and outer hair, the latter slightly posterior, their length nearly equal to the thickness of the larva: the inner hair is dark, and has a remarkable jointed bulb at the base; the outer is transparent and simple; each has a series of points along it, circularly or spirally arranged, so that it looks regularly annulated. There is a supraspiracular (iii) tubercle with a long seta of annulated structure; on the meso- and metathorax this is double, and carries two hairs. On the abdominal segments, tubercle iv (the subspiracular) is separated from iii by an interval (in which is the spiracle?); the hair arising from iv is not so long as those arising from i, ii and iii. The inner dorsal spines incline slightly backwards, the outer ones are curved: the lateral spines are nearly straight and directed outwards. The prolegs carry two fine hairs with battledore tips, projecting downwards, so that they must press on the surface upon which the larva is resting. The true legs carry, in addition to the claw, a similar hair and a battledore-shaped appendage of more ordinary form. The *hybernating larva* is 3·5 mm. long, 1·4 mm. wide, when at rest; 5·0 mm. or more long, when active. On each side of every segment are three great bosses of hairs, a dorsal and two lateral, one above the other, the dorsal the largest, but the three together practically covering nearly the whole segment. The bases of the tubercles are composed of a clear pale skin, but the rest of the general surface is studded with black points. The prolegs are of flange form, and have about 13 hooks, the outer ones rather smaller than the others.

Cocoon.—The cocoon, Buckler says, could be detected by very slight elevations on the surface of the earth, where it had been level before the larvæ buried. They were placed just below the surface of the ground, and were of a broad-oval shape, about 9 lines by 7 or 8 lines, composed outside of grains of earth, very firmly united to a few fibres of grass-roots. On removing the earthy particles, the inner cocoon of opaque greenish-white soft silk is found. This is strong and elastic, resembling that of *Cosmotriche potatoria*, very soft and closely woven anteriorly. Zeller says the brownish-grey cocoon is placed on the surface of the earth, well-concealed, close to the roots of plants. Buckler's description of "greenish-white," and Zeller's of "brownish-grey," for the silk, suggests some variation in this respect. The pupa emerges from the cocoon, and travels to a little distance from it before the imago appears. Buckler found the pupa-skins lying on the bare earth, and only the old shrivelled larval skin in the otherwise empty cocoon.

Pupa.—The pupa is about 13 mm. in length, of moderate substance throughout, with prominent thorax, the wing-covers short, but, towards their ends, projecting a little free from the body, the long antenna- and leg-cases are all free from the body, and seem to be suggestive of locomotion even before the disclosure of the moth; the deeply-divided abdominal rings have each, on the back, near their beginning, a transverse ridge, thickly set with hooks pointing backwards, the top of the abdomen rounded off in a blunt point; the colour of the head, thorax and wing-covers is dark olive-green, and very glossy, the leg-cases and abdomen are of lighter shining green, and the hooks black (Buckler). Chapman gives many further details. He says that the pupa is straw-coloured, narrower and straighter, but reminding one a good deal, at first sight, of *Cochlidion avellana* (*testudo*). A line down the middle of the venter would be straight, the back is rounder, the waist is very slightly marked, flattened from back to front, so that the width is nearly twice the antero-posterior diameter. There is a slightly developed lateral flange carrying the spiracles. The first two abdominal segments, and possibly the third, are apparently fixed, but are free, so far that the appendages are not firmly attached to them, though closely appressed. The first abdominal spiracle is sheltered by the hind-wing, as by a flange lying over it, but is not covered, and, having a ridge just dorsal to it, is, as it were, in a pit, and is quite free and functionally open; the second only just escapes being covered by the hind-wing. There are dorsal rows of spines along the anterior margins of the abdominal segments 2, 3, 4, 5, 6, 7, 8 and 9, very close to the anterior margins, consisting of 14-18 very fine brown spinous points on either side, terminating outwardly at the lateral flange. The anal armature is nil, nor have any other hairs or spines been detected. The posterior margin of each abdominal segment, and even of the third thoracic, is a raised ridge, and overhangs the next segment. The head very definitely extends outside the general level, and forms a knob or boss, whether viewed laterally or ventrally. The eyes and eye-plates extend very low down laterally, and the mouth-parts are placed unusually forward between them. The legs, antennæ, etc., are rounded, and stand away from the body of the pupa. The first pair of legs and the antennæ are most prominent; the second pair and the maxillæ dipping beneath them, the maxillæ partially, the legs entirely, the tarsi appearing again beyond them; the third pair of legs extend several segments beyond the wings, the tarsi of the second pair and the antennæ slightly so; the posterior cephalic plate is very distinct, but there is no definite trace of maxillary palpi; a large portion of the femur (?) appears between the maxillæ and first pair of legs.

Dehiscence.—The abdomen is quite free; the antennæ lifted up from the groove and separated from the appendages, but remain attached to the head; the post-cephalic plate remains attached to the prothorax, but does not carry the eyes; the front parts (except the antennæ) remain (with the eyes) in one piece.

Food-plants.—*Centaurea nigra* (Buckler); *Centaurea scabiosa* (Kirby); *Centaurea jacea* (Zeller). [*Poterium sanguisorba* (Weir), *Globularia vulgaris* and *G. alypum* (Millière), and *Plantago lanceolata* (Kaltenbach) are also reputed food-plants.]

Parasites.—From a pupa, Buckler bred, July 9th, 1883, an undescribed species of *Anomalon*. The pupa-skin of the parasite was found within that of the pupa of the moth, so that the cavity of the pupal body had been the puparium of the parasite.

Habits and habitat.—This species occurs on sunny hill-sides in our south-eastern English counties. It is extremely local, and was first recorded as being captured in this country by Weir (*Zoologist*, 1845, p. 1085). The specimens were captured on the downs (Cliffe Hill), near Lewes, and from this, and adjacent localities, most of our British collections are now supplied with specimens. It frequents here, a steep grassy slope facing south-east, in rather a windy spot. In Kent, it occurs on the hills behind Folkestone and Shorncliffe Camp.

Time of appearance.—Unwin notes the insect as "on the wing for only a short time, and then very sluggish; June 14th being its usual time of appearance, and then only for a day or two can it be taken in fine condition." It varies, however, according to the season, as the recorded dates show: June 15th, 1845, at Cliffe Hill (Weir), June 18th-30th, 1856, at Hollingbury Coombe (Image), June 13th, 1858, June 29th, 1859, June 20th, 1861, at Hollingbury Hill (A. H. Jones), June 7th, 1858, at Hollingbury Vale (Knaggs), June 19th, 1858, nr. Brighton (Beauchamp), June 13th-20th, 1859, on hill at back of Shorncliffe Camp (Rogers), June 25th, 1869, at Folkestone (Ullyett), beginning of July, 1869, at Folkestone (Vaughan), June 9th, 1870, June 15th, 1871, nr. Lewes (Jenner), July 19th, 1879, at Folkestone (Wellman), July 9th, 1883, bred (Buckler), June 10th-15th, 1885, June 16th-27th, 1888, June 10th-16th, 1891, May 31st, 1892, May 27th, 1893, abundant, June 24th, 1894, June 14th, 1896, common, nr. Lewes (W. E. Nicholson), June 15th, 1890, nr. Brighton (Meaden), June 10th, 1894, at Glynde (Lowe). Zeller bred it on June 28th, 1849, and notes the capture of imagines on June 23rd, 1864, at Glogau. The statement of Prittwitz that it is double-brooded in Silesia appears to require confirmation.

Localities.—Kent: hills near Folkestone (Vaughan), hill at back of Shorncliffe Camp (Rogers). Sussex: Hollingbury Vale, Coombe, Cliffe Hill, nr. Lewes, the Devil's Dyke, nr. Brighton, nr. Abbott's Wood (W. E. Nicholson), Glynde (Lowe). [Probably erroneous, and want confirmation:—Cumberland: Orton Moss (Kirby). Gloucester: Cheltenham (Douglas), Newnham, at light (Bingham). Kent: nr. Gravesend (Button). Merioneth: Dolgelly (De Mattos), Barmouth (Pearson). Surrey: Reigate (De Mattos). Warwick: nr. Birmingham (Green). Yorks: Aysgarth (Rowntree).]

Distribution.—Algeria, for var. *cognata* (Lucas, *teste* Staudinger). Asia Minor: Armenia (Staudinger), Gülek (Röber). Austria: Vienna (Zeller), Bohemia, Brünn, Linz, Carniola, Botzen, Hungary (Speyer), Mehadia, Lower Hungary (Staudinger), Dalmatia (Lederer). Belgium (Kayser). Bulgaria: Sofia (Bachmetjew). France: Nohant, Sologne, forests of the Cher, Murols, St. Nectaire, Auvergne (Sand), Chartres (Godart), Basses-Alpes (Millière), Depts. Moselle, Maas, Meurthe, Doubs, Puy-de-Dôme, Digne, Compeigne (Speyer), St. Martin Lantosque (Constant), nr. Paris (Staudinger). Germany: general in south Germany (Hofmann), Glogau, Jena (Zeller), Neuhaldensleben (Heinemann), Tannenwald, Nonnenbruch, Grenzacher-Hörnli (Peyerimhoff), Eastern Prussia (Halffter), Thuringia, Gotha, Erfurt (Knapp), Pomerania, Sachsenwald, Weimar, Giessen, Frankfort-on-Main, Wiesbaden, Bingen, Darmstadt, Stuttgart (Speyer), Ratisbon (Herrich-Schäffer), Augsburg (Freyer), Constance, Speier, Pfalzburg, Freiburg, Gailingen, Upper Albthal, Karlsruhe, Durlacher Wald, Würtemburg, Nassau (Reutti). Greece: Karpinisi (Staudinger). Italy: common in northern, central and southern Italy (Curò), Calabria (Costa), Piedmont, Florence (Lederer). Netherlands: Luxemburg (Speyer). Roumania: Grumazesti, Slanic (Caradja), Cincorova (Mann), Comanesti (Leon), Turn Severin (Haberhauer). Russia: mths. of Danube to Dnieper, Kiev, etc., Astrakhan, Saratov, Kasan (Erschoff), Orenburg, Lower Volga and Ural districts, nr. Sarepta (Eversmann). Spain: Prov. of Teruel (Zapater and Korb), Ronda, Andalusia (Speyer), Granada for var. *soror* (*cognata*, Lucas) (Rambur). Switzerland: Basle (Peyerimhoff), Berne, Siselen, Gadmen (Rätzer), Simplon, Zermatt, Valais (Jäggi), Aarau, nr. Boll, Lucerne, common (Meyer-Dür), Aargau, Born, Engleberg, Wartburg (Wullschlegel), nr. Aarburg (Rothenbach), Biel, Bechburg (Riggenbach-Stehlin), St. Blaise-Neuveville (Couleru), nr. Zürich (Huguenin), upper part of Thalweil, 1472′ (Snell), Trofoi, 4800′ (Frey), Glarus (Speyer), Visp Valley (Jordan).

Subfam.: ANTHROCERINÆ.

Tribe: ANTHROCERIDI.

Genus: ANTHROCERA, Scopoli.

SYNONYMY.—Genus: *Anthrocera*, Scop., "Introd. Hist. Nat.," p. 414 (1777); Stephs., "Ill. Brit. Ent.," i., p. 106 (1828); Wood, "Ind. Ent.," p. 11 (1839); West. and Humph., "Brit. Moths," i., p. 29 (1843); Sta., "Man.," i., p. 79 (1857); Wallgrn., "Skand. Het.-Fjär.," p. 88 (1863); Buckler, "Larvæ," etc., ii., p. 9 (1887); Auriv., "Nord. Fjäril.," p. 52 (1888); Kirby, "Cat. Lep. Het.," p. 62 (1892); "Handbook Lep.," iii., p. 86 (1897); Reuter, "Macro-Lep. Finl.," p. 21 (1893). *Sphinx*, Linné, "Sys. Nat.," x., p. 494 (1758); "Fauna Suec.," p. 290 (1761); Brün. and Pont., "Danske Atlas," i., pl. xxx. (with ref. to Brünnich, "Prod. Ins.," p. 29) (1761); Denis and Schiff., "Sys. Verz. Schmett.," p. 35 (1776); Müll., "Zool. Dan.," p. 116 (1776); Scheven, "Naturf.," x., p. 97 (1777); Fuessly, "Mag. Ent.," i., pp. 124-125 (1778); "Neues Mag.," ii., pp. 207-208 (1785); Esp., "Die Schmett.," ii., p. 138 (1780); p. 186 (1781); p. 222 (1783); Bork., "Sys. Besch.," ii., p. 12, in part (1789); De Vill., "Ent. Linn.," ii., p. 114 (1789); Hb., "Btr. Ges. Schmett.," ii., pp. 19-20 (1790); "Eur. Schmett.," ii., pp. 77-83 (? 1805); Hoh. and Rein., "Bot. Reisen," etc., p. 265 (1792). *Zygaena*, Fab., "Sys. Ent.," p. 550 (1775); "Illig. Mag.," vi., p. 289 (1807); Fuessly, "Mag. Ent.," i., pp. 113-114 (1778); Cuv., "Tabl. Elem. Nat. Hist.," p. 593 (1799); Schrank, "Fauna Boica," ii., p. 237, sect. B (1801); Haw., "Lep. Brit.," i., p. 74 (1803); Ochs. and Treitschke, "Schmett. Eur.," ii., p. 20 (1808); x., p. 103 (1834); Latr., "Gen. Ins.," iv., p. 212 (1809); Dalm., "Vet. Acad. Handl.," p. 223 (1816); Godt., "Lép. France," p. 125 (1821); Bdv., "Mon. Zyg.," p. 24 (1829); "Icones," ii., p. 35 (1832); "Species Gen. Lép.," i., pl. xv., fig. 7 (1837); Costa, "Faun. Nap. Lep.," p. 14 (1832); Freyer, "Neuere Beiträge," etc., i., p. 28 (1833); Curt., "Brit. Ent.," xii., pl. 547

(1835); Dup., "Lép. France," supp., ii., p. 34 (1835); Zell., "Isis," p. 274 (1839); p. 296 (1847); Zett., "Ins. Lapp.," p. 919 (1840); Evers., "Faun. Lep. Volg.-Ural.," p. 93 (1844); DeSelys, "Mém. Soc. Liége," ii., p. 6 (1845); H.-Sch., "Sys. Bearb.," ii., p. 28 (1845); Assm., "Abbild. Schmett. Schles.," ii., p. 7 (1845); Led., "Verh. zool.-bot. Ges. Wien," ii., p. 93 (1852); Kayser, "Deutsch. Schmett.," p. 168 (1852-1859); Speyer, "Geog. Verb. Schmett.," p. 340 (1858); Ramb., "Cat. Lep. And.," p. 161 (1858-1866); Hein., "Die Schmett.," i., p. 154 (1859); Lucas, "Hist. Nat.," 2nd Ed , p. 150 (1864); Birch., "E.M.M.," iii., p. 33 (1866); Snell., "De Vlinders," p. 126 (1867); Nolck., "Lep. Fn. Est.," i., p. 97 (1868); Newm., "Brit. Moths," p. 23 (? 1869); Staud., "Hor. Soc. Ross.," vii., p. 102 (1871); Staud. and Wocke, "Cat.," p. 45 (1871); Mill., "Cat. Lép. Alp.-Mar.," p. 125 (1872); White, "Scot. Nat.," i., p. 175 (1872); Cuní y Martorell, "Cat. Met., Lep.," p. 47 (1874); Curò, "Bull. Soc. Ent. Ital.," vii., p. 194 (1875); Oberth., "Etudes d'Entom.," i., p. 33 (1876); viii., p. 27 (1884); xii., p. 23 (1888); xiii., p. 19 (1890); Sand," Cat. Lép. Auv.," p. 22 (1879); Frey, "Lep. der Schweiz," p. 64 (1880); Peyer., "Cat. Lep. Als.," p. 47 (1880); Schöyen, "Norg. Ark. Reg. Lep.," p. 171 (1881); Hofmn., "Die Gross-Schmett.,' etc., p. 33 (1887); "Die Raupen," etc., p. 35 (1893); Hampson, "Fauna of India," i., p. 230 (1892); Chapmn., "Trans. Ent. Soc. Lond.," p. 111 (1893); Ibid., pp. 344 and 349 (1894); Meyr., "Handbook," etc., p. 446 (1895); Tutt, "Brit. Moths," p. 351 (1896). *Adscita*, Retz., "Gen. et Spec. Ins.," pp. 8 and 35, in part (1783); Esp., "Die Schmett.," ii., p. 223, in part (1783). *Thermophila*, Hb., "Verz.," p. 117 (? 1822). *Hesychia*, Hb., "Verz.," p. 116 (? 1822). *Agrumenia*, Hb., "Verz.," p. 116 (? 1822). *Eutychia*, Hb., "Verz.," p. 117 (? 1822). *Anthilaria*, Hb., "Verz.," p. 117 (? 1822). *Aeacis*, Hb., "Verz.," p. 117 (? 1822). *Lycastes*, Hb., "Verz.," p. 118 (? 1822). *Mesembrynus*, Hb., "Verz.," p. 118 (? 1822).

Scopoli's diagnosis of the genus reads (*Introd. Hist. Nat.*, p. 414) as follows:—

> Antennæ nigræ, subclavatæ. Alæ longæ, maculatæ. Volatus diurnus. Larva Phalæniformis, segnis, pilosa, capite parvo. Pupa exposita intra folliculum lucidum. *S. filipendulae*, etc.

The citation of *filipendulae* constitutes this as the type of the genus. The chief characters of the genus may be summarised as follows:—

Ovum.—Oval in outline, long axis horizontal; pale yellow or pale greenish in colour, one pole transparent; smooth, or very faintly reticulated.

Larva.—Flattened ventrally; head retractile; in 1st stage tubercles i-ii simple, trapezoidal in position; iii, iv, v simple; converted into hair-bearing warts after first stage, i united to ii, and iv to v; hairs spined; prolegs well-developed, of Macro type; feeds exposed; spins a fusiform or oval silken cocoon, frequently attached to culm, plant-stem or stone.

Pupa.—Dorsal headpiece well-developed; maxillary palpus practically obsolete, movable abdominal segments (? 1, 2) 3, 4, 5, 6, 7 in male, (? 1, 2) 3, 4, 5, 6 in female.

Imago.—Tongue developed; antennæ dilated towards apex to form a club, tip pointed; palpi porrect; frenulum present; nervures 9, 10, 11 of fore-wings stalked together. Hind-wings with all the nervures from the cell.

With the exception of *Arichalca*, Wallgrn., from Zambesi and Caffraria, *Arniocera*, Hopff., from Mozambique, *Neurosymploca*, Wallgrn., from Caffraria, Matabeleland and the Cape, and *Zutulba*, Kirby, from Natal, the Cape, Caffraria, and doubtfully from north and north-west India, Kirby includes (*Cat. Lep. Het.*, pp. 62-79) the whole of the Anthrocerids, *i.e.*, the Burnets proper, in the genus *Anthrocera*. There is no doubt that when more is known of the early stages of these insects, many well-defined genera will be found united under this name. Hübner divided (*Verz.*, pp. 116-118) the European species known to him, and now included in this genus, into no less than eight genera, as follows: (1) *Hesychia—laeta*, *hilaris*, *fausta*, *faustina*. (2) *Agrumenia—phacae*, *onobrychis*, *hedysari*, *meliloti* (= *carniolica*, Auct.). (3) *Eutychia—rhadamanthus*, *caffra*. (4) *Anthilaria—spicae*, *lavandulae*. (5) *Aeacis—ephialtes*. (6) *Thermophila—aeacus*, *peucedani*, *medicaginis*, *charon*, *viciae* (*melilothi*), *angelicae*, *lonicerae*, *hippocrepidis*, *filipendulae*, *transalpina*, *cytisi*, *orobi*, *trifolii*, *glycirrhizae*. (7) *Lycastes*

—*sedi*, *anthyllidis* (*triptolemus*), *bellidis* (*bellis*), *loti* (*achilleae*), *exulans*, *cynarae*, *sarpedon*. (8) *Mesembrynus*—*brizae*, *scabiosae*, *punctum*, *pluto*, *minos*, *erythrus*, *rubicundus*. We are quite prepared to believe that our British species are members of at least four different natural genera. Bowell has shown that the scales of *A. purpuralis* (*minos*) are more generalised than those of the *A. filipendulae-lonicerae* group, and it is well-known that *A. exulans* shows very marked characters in its pupa and cocoon. If our British species were to be subdivided, we should have the following groups:—

1.—*Mesembrynus*—*purpuralis* (=*minos*, *pilosellae*).
2.—*Lycastes*—*exulans*.
3.—*Thermophila*—*viciae* (*meliloti*).
4.—*Anthrocera*—*lonicerae*, *paludis* (*trifolii-major*), *trifolii-minor*, *hippocrepidis*, *filipendulae*.

Anthrocera is a most attractive genus of moths, and to one who has studied the extra-British species, offers much of interest. The species, popularly known as Burnet moths, have usually dark green or dark purplish-blue fore-wings, with crimson spots and crimson hind-wings. The males inclining to the purple, the females to the greenish, hue. The interest is partially due to the generalised nature of the genus, exhibited particularly in the pupa and in the neuration of the imago, but still more so to the more or less undefined character of some of the species, which, distinct enough in habits, habitat and time of appearance, yet present many difficulties in the determination of the imagines, which also, in some instances, hybridise very freely.

When one has a short series of any one of these species, he is quite prepared to give a confident opinion as to that particular species. As the number of specimens examined increases, the opinion becomes less confident, and when the number becomes still more largely increased, the opinion is never stated as being more than probable. Whenever we express any opinion as to these species, we wish it to be understood that it must generally be considered as only a probable one.

The Anthrocerid egg is ovoid, oblong, pale yellow or greenish in colour, very shiny, with one pole transparent, generally smooth, but rarely very faintly reticulated, the eggs of the various speices being very similar. The egg stage rarely lasts more than fourteen or fifteen days.

The newly-hatched larva is very pale, and those of different species are very similar. They all have tubercles i and ii (Dyar's nomenclature) arranged as anterior and posterior trapezoidals on both thoracic and abdominal segments, and each bears a single hair; iii is placed as a supraspiracular, iv and v being both placed as subspiraculars. After the first moult these simple single-hair-bearing tubercles are modified, a swollen base uniting i and ii on either side, and bearing several single-haired warts; iv and v are similarly united into a common subspiracular mass, whilst iii is also of a more complex structure. With the exception of changes in the depth of tint, the larva is structurally identical from this time with the adult form. The species hybernate as larvæ, moderately small, usually feeding a little through August and September, and commencing to feed again in spring. Boisduval states that they only feed for a fortnight before becoming torpid, but this is not so with many species—*A. lonicerae* reaches its fourth skin, *A. viciae* (*meliloti*), *A. filipendulae* and *A. carniolica*, the third, before hybernating. All these feed some 8-10 weeks before hybernation. Many larvæ that commence feeding in the spring eat only for a short time, and then æstivate and hybernate again for a full year, feeding up the next year. Boisduval says that three changes of skin only occur in the spring. This also can only be true for a limited number of species.

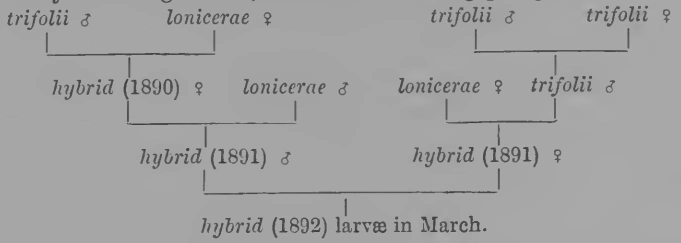
When the larvæ of *A. trifolii*, *A. filipendulae* and their allies are ready to hybernate, they spin a silken pad, on which they moult before hybernation. At the same time they lose their green tint and become of a sandy hue. The larvæ feed in the spring before moulting again. The moulting of the Anthrocerid larva is peculiar. It is not effected by creeping out of the old skin through an aperture made in the thoracic segments or head, but the larva simply remains quite still, whilst the skin bursts open mediodorsally the whole length of the back.

The food-plants of the larvæ of this genus consist almost entirely of herbaceous leguminous plants—*Vicia*, *Coronilla*, *Lotus*, *Hippocrepis*, *Medicago*, *Trifolium*, *Onobrychis*, etc., and Boisduval asserts that they will not touch arborescent leguminous plants. The naming of many species by the early entomologists, after plants belonging to other natural orders, owing to a supposed connection between the insect and the plant, is frequently based on error, *e.g.*, such names as *filipendulae*, *cynarae*, *achilleae*, *lavandulae*, *peucedani*, *brizae*, etc. Yet the larvæ of some species are not altogether confined to a leguminous diet, that of *A. erythrus* is stated by Millière to feed on *Thymus*, Nicholson says that *A. sarpedon* feeds on *Eryngium*, whilst *A. purpuralis* (*minos*) and *A. exulans* have the reputation of feeding on quite a number of plants other than those belonging to the *Leguminosae*. We are inclined to think that the more polyphagous species of this genus are, as a rule, the more ancestral ones.

The full-grown larva usually forms a spindle-shaped, white or yellow, silken cocoon, which is fixed either to the stem of a plant or to the ground. (The cocoon of *A. nicaeae*, however, is quite oval in shape, differing very much from a typical Anthrocerid cocoon.) The pupa is remarkable as being of a very generalised type, with the appendages long, and free from the abdominal segments; of the latter 3-7 are free in the male, 3-6 in the female; the abdominal segments 1, 2 are also more or less free in both sexes. The pupal state usually lasts but a short time, and, just before the emergence of the imago, the pupa pushes itself partly out from the upper end of the cocoon, the imago liberating itself from the protruding chrysalis. We are not aware that any really double-brooded species of this genus exists in a state of nature. Millière certainly gives *A. fausta*, and doubtfully *A. achilleae*, as being so in southern France, and Boisduval also suggests the double-broodedness of the latter species, but our observations on this species there are contrary to this view, and Boisduval's own reason, founded upon a comparison of the dates of emergence of the species in the neighbourhood of Paris with those in the higher mountains of Dauphiné, is not at all convincing. Ochsenheimer met with two newly-emerged specimens of *A. trifolii* in late autumn, and Zeller found a late autumnal freshly-emerged specimen of *A. filipendulae*, the latter suggesting that these were second-brood specimens from larvæ that had not become torpid. The probability is, however, all the other way, as we have found belated specimens of *A. filipendulae* in Kent in September, when the bulk of the imagines have appeared in late July and August, and have always supposed that such larvæ have fed up after perhaps commencing to æstivate (and hybernate) a second time. Zeller notes also the capture of *A. ochsenheimeri* in Syracuse, in April, and asserts that he took four small male specimens of the same species on September 4th, near Talentino, and others on September 11th, near Ancona. These he supposed represented a second brood. Girard met with fresh specimens of *A. trifolii* of both sexes at Trouville-sur-Mer (Calvados) on Sept. 29th-30th, 1880, in a locality in which the species usually occurs in June, and surmises that the fine weather of September had caused their development as a partial second brood. Fletcher has found that, in captivity, *A. trifolii* is to a very limited extent double-brooded. From eggs obtained early in June in the years 1892 to 1897 (both inclusive) he bred 11 specimens, all from eggs of the years. He has further attempted to force on a second brood, by putting the young larvæ in a south window, where they were exposed to the warmth of the sun, modified by whitened glass, but without any result. With the exception of this evidence of Fletcher's, that relating to second-brooded Anthrocerids is far from satisfactory. Difference of altitude, and, above all, meteorological conditions often affect the emergence of insects, locally. On the other hand, many Anthrocerid species pass more than one year in the larval stage, *i.e.*, a large percentage of individuals of these species do so. To such an extent is this habit developed in some species, that every individual of some Scotch *A. filipendulae*, which Fletcher procured for experimental purposes in 1896, in spite of their removal to Sussex, after hybernating during the winter of '96-'97, hybernated a second time during the winter of '97-'98. He has also had other Anthrocerid larvæ pass a third winter in that stage.

The close alliance that exists between many Anthrocerid species has led to cases of cross-pairing between some of them. It has been recorded as occurring between *A. filipendulae* ♂ and *A. achilleae* ♀, eggs obtained, larvæ hatched, but failed to reach maturity (Guenée), *A. filipendulae* and *A. ephialtes* (Treitschke), *A. lonicerae* and *A. filipendulae*, *A. filipendulae* and *A. hippocrepidis*, *A. filipendulae* and *A. peucedani*, *A. trifolii* and *A. hippocrepidis* (Boisduval), *A. minos* and *A. filipendulae* (Villiers). Boisduval says (*Icones*, ii., p. 36) that in this cross-pairing *A. filipendulae* is always one of the species, although he had previously stated (*Monog. des Zygénides*, p. 5) that he had many times found *A. trifolii* paired with *A. hippocrepidis* (= *A. transalpina*). He further remarks that he has never been able to obtain eggs from these cross-pairings to hatch, although he believes it probable that some eggs do so in nature. Cross-pairing has also been recorded between *A. filipendulae* and *A. trifolii* by Weir, but Fletcher says with regard to this : "Seeing the great difficulty of pairing *A. filipendulae* and *A. trifolii* in captivity, I should want strong evidence, actual paired specimens with history, before believing that they paired in nature, and actually bred and labelled hybrids before believing in them at all." Weir notes the possession of two hybrid *trifolii* × *filipendulae* taken wild, but Fletcher has the specimens, and refers one to *A. trifolii* ab. *basalis*, the other to, probably, *A. hippocrepidis*, St. Zeller concludes (*Isis*, 1840, p. 137) that "the formation of Zygænid species is not yet at an end, because of the constant copulation of specimens of different species without constraint, and when in a condition of perfect liberty." We believe he gives none of the details, however, on which he based this conclusion. Goossens notes (*Ann. Ent. Soc. Fr.*, (5) vi., p. 432) that he obtained fertile eggs from a pairing of *A. hippocrepidis* with *A. peucedani*, all the larvæ dying after the second moult, the same in the case of *A. fausta* with *A. hippocrepidis.* Rogenhofer (*S. B. z.-b. Wien*, xxxviii., p. 74) notes cross-pairing between *A. carniolica* ♂ and *A. filipendulae* ♀, *A. ferulae* (*transalpina*) ♂ and *A. carniolica* ♀, *A. filipendulae* ♂ and *A. ferulae* ♀. He also records a pairing between *Zygaena* (*Syntomis*) *pheyea* ♂ and *A. filipendulae* ♀.

Our actual knowledge of the hybridisation of these species is almost entirely due to Fletcher. During 1889 and 1890, Fletcher reported breeding hybrids between *A. lonicerae* × *A. filipendulae* (hybr. *lonicerae* × *filipendulae*). These were intermediate in markings between the parents, some of the males showing only a slight trace of the sixth spot when examined with a strong lens, while some of the females have it as well developed as it is in typical *A. filipendulae.* They were very large, one with an alar expanse of 40 mm. Two pairings of the hybrids were obtained, but none of the eggs hatched, yet Fletcher concludes that he is not justified in assuming that the cross between these two species is always sterile. In 1891 and 1892, Fletcher succeeded in rearing hybrids of both the crosses obtainable between *A. lonicerae* and *A. trifolii*, *viz.*, *lonicerae* ♂ × *trifolii* ♀ and *trifolii* ♂ × *lonicerae* ♀ (= hybr. *lonicerae* × *trifolii* and hybr. *trifolii* × *lonicerae*). Unlike the *filipendulae* × *lonicerae* hybrids, these laid fertile eggs, and, in 1892, specimens of the following crosses were obtained: *hybrid* ♂ × *trifolii* ♀; *lonicerae* ♂ × *hybrid* ♀; *hybrid* ♂ × *hybrid* ♀. In March, 1893, he had hybernating larvæ, with the following pedigree:



We are informed that these experiments were not carried further, the fertility of the hybrids being already abundantly proved. The two species, *A. lonicerae* and *A. trifolii*, pair freely *inter se.* On the other hand, only a few pairings could be obtained between *A. filipendulae* and *A. lonicerae.* Single couplings were also obtained between *A. filipendulae* and *A. trifolii*, and between *A. filipendulae* and *A.* hybr. *lonicerae* × *trifolii*, but these failed to produce fertile eggs.

Among the hybrid *lonicerae* × *trifolii* there is a strong tendency to resemble the mother, although when several of a brood are seen together the influence of both parents is very marked. Thus, out of several hundreds of specimens of *A. lonicerae* from Kent, Notts and York, which Fletcher had bred during the last few years (1889-1895), not one had the central pair of spots united, whilst among every brood of the hybrids some have had them united. When *A. trifolii* has been the female parent, several have had all the spots run together as in the ab. *minoides* (*confluens*) of *A. trifolii*; a more extreme form, too, occurs, in which the red scales are spread beyond their usual limits, so as to occupy most of the fore-wings, except the hind margin and a narrow stripe next to the inner margin. The influence of *A. lonicerae* is shown by the greater opaqueness of the fore-wings, the acuteness of the hind-wings and by the shape of the antennæ.

Fletcher has made attempts to cross *A. viciae* (*meliloti*) with *A. filipendulae*, *A. lonicerae*, *A. trifolii*, and with hybrids between the last two species. As a result he obtained two pairings between *A. viciae* and *A. filipendulae*, and one pairing between *A. viciae* and *A.* hybr. *lonicerae* × *trifolii*. He failed entirely to obtain a pairing between *A. viciae* and *A. trifolii*. The eggs resulting from the above pairings all failed to hatch, and pairings between *A. filipendulae* and *A. trifolii* have also, so far, always resulted in infertile eggs. The fertile crosses that Fletcher has obtained up to date are: *filipendulae* × *lonicerae*, *lonicerae* × *filipendulae*, *trifolii* × *lonicerae*, *lonicerae* × *trifolii*, *filipendulae* × *ochsenheimeri*, *ochsenheimeri* × *filipendulae*, the first-mentioned in each crossing being that of the male parent. Standfuss records the rearing of hybrid *filipendulae* × *trifolii*, a crossing with which Fletcher failed (*ante*, p. 418). He further states that the progeny were intermediate.

White figured and described (*Ann. Ent. Soc. France*, (5) viii., pp. 467-476, pl. xi-xii) the genital armatures of various Anthrocerid species. For the following account of the genital male organs of *Anthrocera* we are indebted to Bateson, who writes: The accessory male organs in *Anthrocera* present a considerable amount of complexity, and their anatomical relations are not very easily made out. The peculiarities, however, which distinguish these parts in the different species may for the most part be recognised without any difficulty. For systematic purposes, the following parts are the most useful:—

1. The *uncus*, consisting of two processes articulating with the *tegumen*, or last dorsal segment. In some species these processes are short, wide flaps, in others they are more or less slender horns.
2. The *rasps*, formed by the development of patches of peculiar teeth upon the *dorsal* and *ventral* extensions of the sheath of the penis. These rasps are very characteristic of the genus. The *dorsal rasp* is in most species made up of large and small teeth. The large teeth are set in two rows, converging towards the apex, bounding a central area covered with very minute teeth. In some species the two rows of large teeth meet each other also towards the base of the rasp, across the central area of which a part is thus enclosed as a lozenge-shaped space. Outside the large teeth are smaller teeth, arranged in various ways. Sometimes the large teeth are sharply differentiated from the rest, but in other species there is no clear distinction between large and small, the one shading into the other. The *ventral rasp* is usually much smaller. It consists of a simple patch of differentiated teeth.
3. The *spines on the wall of the penis* itself. When the penis is retracted, these spines are seen through its walls lying inside it. Morphologically, they are, of course, on the external surface of the penis.

There is a considerable range of individual variation in the first and second characters, but the various species of *Anthrocera* may, nevertheless, be immediately distinguished from each other by reference to them. In respect of the third character, the individual variation is comparatively greater, and, on this account, some species cannot be distinguished by this character alone, though, in other species, the structures are peculiar and quite distinctive.

The arrangements in the British species are as follows;

I. *A. purpuralis* (*minos*).—1. Uncus: Two pointed lobes longer than in *trifolii*, but not produced into horns. 2. Rasps.—*Dorsal rasp*: Tongue-shaped band of teeth, about twice as long as wide. Large teeth, 3-4 in each row. The lateral rows of teeth meet, forming a bridge across the central area. Teeth of central area, except at this bridge, are without points, being scale-like plates of chitin. *Ventral rasp*: Very wide, widening towards apex; in width about equalling dorsal rasp. Contains some hundreds of small teeth, those of the base many-pointed, some being studded over with minute points. 3. Wall of penis contains no horn-like teeth, but near the apex (when retracted) are two patches of small spines.

II. *A. exulans*.—1. Uncus: Strong and horn-like processes, narrowing much more gradually than in *filipendulae* or *viciae*. Thickened along median borders. 2. Rasps.—*Dorsal rasp*: Tongue-shaped, elongated and narrow. Large teeth, about ten in each row. Rows unite across central area. *Ventral rasp*: Elongated band of teeth, not widening noticeably towards apex, about as long as the dorsal rasp. 3. Wall of penis contains no elongated, horn-like teeth, but has a single elongated band of small spines near the apex (when retracted).

III. *A. viciae* (*meliloti*).—1. Uncus: Two processes, wide at base, narrowing (more gradually than in *A. filipendulae*) to cylindrical curving horns. Narrow part is about $\frac{1}{8}$ width at base. The whole uncus is about $\frac{2}{3}$ length of that in *A. filipendulae*. 2. Rasps. *Dorsal rasp*: Much narrower than in *filipendulae*, being about twice as long as broad. Large teeth, about 8 in each row. Teeth of central area for the most part many-pointed. *Ventral rasp*: Tongue-shaped patch of teeth, narrowing towards apex, containing 70-80 teeth. 3. Wall of penis contains elongated, horn-like teeth.

IV. The following description applies both to *A. lonicerae* and *A. trifolii*:—1. Uncus: Two short triangular processes, about $\frac{1}{2}$ length in *filipendulae*, not produced into horns. 2. Rasps. *Dorsal rasp*: General appearance as in *filipendulae*, but only about as long as wide. Large teeth, 10-12 in each row. Rows approach each other at base very little, leaving central area wide. Teeth of central area at base mostly 1-pointed, but towards apex many-pointed. 3. Wall of penis contains elongated, horn-like teeth.

A. lonicerae and *A. trifolii*.—Between specimens referred to *A. lonicerae* and *A. trifolii* respectively there is no visible difference as regards the male organs. I have examined a large series of specimens sent by various persons, especially Mr. W. H. B. Fletcher, as *A. trifolii*, *A. lonicerae*, or as hybrids between the two, and I can find no means of distinguishing them. There are individual differences in number of teeth, etc., but these variations are not correlated with the external characters supposed to distinguish *A. lonicerae* from *A. trifolii*. Having regard to the fact that species of *Anthrocera* can in general be easily distinguished by the male characters, it must, I think, be admitted that *A. lonicerae* and *A. trifolii* are not species in the sense that the other Anthrocerid species are.

V. *A. filipendulae*.—1. Uncus as two processes, wide at the base, narrowing rather abruptly, and continued backwards into long slender horns. In the cylindrical part the horn is about $\frac{1}{15}$ width at base. 2. Rasps. *Dorsal rasp*: length about $1\frac{1}{2}$ times width. Large teeth, 7-8 in each row. Rows approaching each other, but not meeting at base. Teeth of central area mostly 1-pointed. *Ventral rasp*: A patch of 30-40 large teeth and many small ones. The toothed area widens towards the apex. 3. WALL OF PENIS contains elongated horn-like teeth.

Pierce considers (*Brit. Nat.*, 1889, p. 55) that the genital organs are distinct in all our British *Anthrocerid* species. He says that the essential parts of these organs consist of the following parts: (1) Superior or outer appendages (sup. app.). (2) Inferior or inner appendages (inf. app.). (3) Penis collar, a scaly organ, covered with file-like teeth. (4) Penis. An examination of these organs led Pierce to make the following table in illustration of his observations:—

- A. Inf. app. produced beyond the flap.
    - B. Inf. app. very long and slender; collar with large teeth = *A. filipendulae.*
    - BB. Inf. app. shorter, stouter than preceding; collar small, teeth very small = *A. exulans.*
    - BBB. Inf. app. shorter than preceding; collar larger; teeth much larger than in *A. exulans*, not so large as in *A. filipendulae* = *A. meliloti.*
- AA. Inf. app. not produced beyond the flap.
    - C. Inf. app. very stout, slightly curved at the tip; collar small, with a few small hooks drawn out = *A. purpuralis* (*minos*).
    - CC. Inf. app. shorter, rounder; collar broad, large hooks = *A. trifolii*, *A. lonicerae.*

The most closely allied species of those examined, so far as relates to the genital organs, he considers to be *A. trifolii* and *A. lonicerae.* The hooks on *A. lonicerae* are, however, larger and bolder than those of *A. trifolii*, and hence have a very different appearance, which, however, is difficult to describe in words. This will, perhaps, explain the reason why Fletcher has more readily been able to obtain pairings between these species than any others. At the same time the facts brought forward in this table explain the failure of this experimenter to cross *A. viciae* (*meliloti*) with *A. trifolii*, and Pierce, particularly referring to these species, states that he considers the form of the sexual organs in *A. viciae* (*meliloti*) sufficiently specialised to prevent any successful crossing between it and its allies (*Brit. Nat.*, 1892, p. 80).

It may be here mentioned that male Burnets will pair with three or four females successively, and effectually fertilise their eggs.

Gynandromorphous specimens appear to be rare in this genus. Schultz mentions a specimen of *A. romeo* var. *nevadensis*, the left side ♀, the right ♂, that is in the collection of Dr. Staudinger. He further mentions a specimen of *A. trifolii*, with ♀ left wings of the form ab. *confluens* and ♂ right wings of the ab. *orobi*, but adds nothing as to the condition of the sexual organs.

With very few exceptions, the fore-wings of the Anthrocerids are of a metallic green or purplish-blue colour, with bright scarlet or crimson spots. The two main directions in which the normal red colour is modified in these insects is in the direction of yellow and brown. In a few species, the spots are white in certain forms only, and then only in part, as in *A. ephialtes*, in which the hind-wings and basal spot of the fore-wings are often yellow, the other spots of the fore-wings being white. The change from red to yellow occurs in many, probably in all Anthrocerid species. It has been noticed in *Anthrocera peucedani* ab. *aeacus*, *A. ephialtes* abs. *trigonellae* and *coronillae*, *A. carniolica* ab. *flaveola*, *A. fausta* ab. *lugdunensis*, *A. filipendulae* ab. *flava*, *A. hippocrepidis* ab. *flava*, *A. trifolii* ab. *lutescens*, *A. lonicerae* ab. *citrina*, *A.*

achilleae ab. *flava*, *A. purpuralis* ab. *lutescens*, *A. exulans* ab. *flava*, *A. transalpina* ab. *lutescens*, *A. sarpedon* ab. *flava*, *A. lavandulae* ab. *lutescens*. The red colour of the Anthrocerids is readily acted on by various acids (*vide*, *Brit. Noct.*, etc., ii., p. xi) which change it to yellow, but a careful washing with water, and even long-continued exposure to the air, will, in some instances, restore the colour. Fletcher says that the yellow modification of colour is more or less hereditary, but only a small proportion of offspring turn out yellow when only one parent is yellow. He has never been able to obtain a pairing between a yellow male and yellow female. He is inclined to believe, too, that the male is more potent in carrying on the yellow colour than the female. The attempt to carry on a brood of more or less transparent specimens of *A. filipendulae* has always failed, the offspring being normal. This tends to prove that the latter is simply a pathological condition induced by reduced energy in the individuals affected.

The tendency for the red coloration to become obscurely brown is of very much rarer occurrence. It appears rather frequently in *A. filipendulae*, the form produced being known as ab. *chrysanthemi*, *A. hippocrepidis* ab. *nigricans*, *A. purpuralis* ab. *obscura*, *A. trifolii* ab. *obscura* and *A. lonicerae* ab. *chalybea*.

The blue-green ground colour of the wings is sometimes mixed with silvery-grey or golden-yellow scales. Both forms are not at all infrequent in *A. exulans*, and the latter is well-marked in *A. achilleae* ab. *bitorquata*. Sometimes the blue-green scaling is changed to a pallid brownish, as in *A. filipendulae* ab. *grisescens*, but this appears to be a marked pathological condition, differing somewhat from the preceding, and almost of the same nature as the conditions, which produce an odd pallid wing, whilst the others are normal, and so on. Then again, certain species, with normally distinct spots, may present confluent aberrations, *e.g.*, *A. exulans*, *A. viciae*, *A. lonicerae*, *A. trifolii*, *A. filipendulae*, etc.; others with yellow rings surrounding the red spots are so modified that the pale cincture may be absorbed in the red, or, on the contrary, may absorb it, extreme cases occurring in *A. carniolica* and its allies. The abdominal red belt also, in those species which possess it, may vary in colour, may exist as a double or single ring, or may be altogether suppressed. The width of the dark marginal band of the hind-wings also varies greatly; in some species aberrations are found in which almost the whole of the red colour is absorbed.

The variation that occurs in the mode of spotting of the Burnets forms a very interesting study. The species divide up roughly into the following groups:—(1) With six crimson spots. (2) With five crimson spots. (3) With three longitudinal blotches. (4) With five crimson spots, and a sixth transverse lunular spot parallel with the hind margin. The species of the latter group are strongly inclined to have the crimson spots outlined with cream colour. (5) With three transverse blotches, apparently formed of 1 + 2, 3 + 4, 5 + 6 in *A. cuvieri* and 1 + 2, 3 + 4, 5 + outer transverse mark of group 4 in *A. olivieri*. On the whole, this group seems more allied to group 4 than to any other. Bateson observes that a similar series of grouped forms can be arranged according to the characters exhibited by the male genitalia, but the two series do not correspond at all closely with each other.

The most extreme form of blotching is observed in *A. erythrus* and certain forms of *A. purpuralis* (*minos*), in which the whole of the central area of the wing is entirely red. Standfuss says that individual examples of *A. achilleae*, *A. brizae*, *A. viciae*, *A. trifolii* and *A. lonicerae* present aberrations occasionally almost entirely red in colour. The next step is that in which the red is broken up into three wedge-shaped blotches, as in typical *A. purpuralis* and *A. punctum*, the formation of these exhibiting the origin of the spotted forms. In the least strongly blotched species of this group, *e.g.*, *A. scabiosae* and *A. brizae*, these wedge-shaped blotches are reduced to lines, and often give a distinct idea of two basal, two central, and an apical spot being united (the upper central to the apical, and the lower central to the lower basal). Coming to the five-spotted forms, we find certain species with the apical spot not particularly large, but oval, as in *A. lavandulae*, *A. lonicerae*, *A. trifolii*, *A. viciae* (*meliloti*) and *A. exulans*, whilst a second group, represented by *A. achilleae*, has the apical spot very large, suggesting a double-spotted origin (or a tendency to cover the area occupied by the two outer spots in the next group). The six-spotted group is interesting—*A. hippocrepidis*, Stphs., and *A. ochsenheimeri* (from the Alps), having the sixth spot ill-developed in the male (sometimes only visible beneath), but well-developed in the female, whilst *A. filipendulae*, *A. transalpina*, etc., have the six spots well developed in both sexes. It must be from near the first of these latter groups that *A. peucedani* obtained its variable spotting. The *ochsenheimeri* group leads naturally up to the five-spotted forms—*A. trifolii*, *A. lonicerae*, *A. viciae* (*meliloti*), *A. exulans*, etc. The last group to be considered has five red spots and an outer transverse lunular mark, and is very near the five-spotted species, in spite of the remarkable creamy rings that surround the red spots of such species as *A. carniolica*, *A. occitanica* and *A. fausta*, for in *A. carniolica* ab. *berolinensis* the creamy rings have not yet appeared (or have been suppressed), and in some extreme forms of this aberration the outer transverse band is reduced to a mere red scale or two, and is occasionally absent altogether. In this state, it is difficult to separate from a small *A. trifolii*. The blotched aberrations of the species of this group, too, form their blotches as in confluent *A. trifolii*, and not as in *A. purpuralis* (*minos*), that is, they unite in adjacent pairs—basal with basal, central with central—and then by transverse lines uniting them more or less centrally, and thus do not form three wedge-shaped spots, but a real blotch. *A. exulans* and *A. viciae* (*meliloti*) blotch rarely, but when they do, the tendency is to follow *A. purpuralis* (*minos*).

In speaking of these spots in detail, it is well to have some sort of nomenclature. For this purpose, we use the numbers 1, 2, 3, 4, 5, 6. 1 is the upper and 2 the lower of the basal spots; 3 and 4 are the upper and lower of the middle pair respectively; 5 and 6 the upper and lower of the outside pair. In the type of *A. purpuralis*, 1 is continued along the basal half of the costa, forming a wedge-shaped spot; 2 is joined with 4 into a second blotch, whilst 3 is joined to 5 (and somewhat enlarged towards 6) to form a third blotch. The three being generally separated by the green nervures that fall between them. In the ab. *pluto*, the extension of the blotch 3 + 5 is not enlarged towards 6, but is cut off sharply on the outer edge of 5; whilst in the ab. *polygalae*, the blotches characteristic of the typical form are not separated by the darker nervures, but occupy the greater part of the area of the wing as a single red blotch. The form known as *A. exulans* ab. *pulchra* is an almost parallel form to *A. purpuralis* ab. *polygalae*, but yet shows some traces of the yellow nervures that separate the three blotches ; *A. exulans* ab. *striata* tends in the direction of joining 3 and 5 or 2 and 4 by fine red lines. In *A. lonicerae*, there is a tendency for 1 to form a long wedge-shaped spot along the basal half of the costa, then for 2 and 4 to run together and make a somewhat straight line parallel with the inner margin, as in *A. purpuralis.* Here the similarity seems to end, for 4 now joins with 5, and then falls back to include 3, so that at length 2, 3, 4 and 5 form a large roughly wedge-shaped spot with the apex of the wedge at 2, and its base extending along the outer edge of 5 to 4, and roughly parallel with the outer margin of the wing. This also seems to be the line taken by *A. filipendulae*, but in this, after 2 and 4 have become united, 3 will join into the blotch at 4, and also with the united 5 + 6, leaving a space between 4 and 5 + 6. If now we examine *A. trifolii*, we observe that the commonest form of blotching is that by which 1 + 2, 3 + 4, and 5 become three separate spots. Then we observe that 1 + 2 is joined to 3 + 4 by a narrow line = ab. *basalis*, Selys, and in others that 3 + 4 is joined to 5 in the same manner = ab. *glycirrhizae*, Hb. The next step is 1 + 2 joined to 3 + 4 by a red line, and 3 + 4 joined to 5 by another red line, so that we have two terminal and a central blotch, borne, as it were, on a central bar = ab. *minoides*, Selys = *confluens*, Stdgr. The growth of this bar continues, in some instances, until the whole central area is practically filled up. Such an aberration is figured by Christy (*Entom.*, vol. xxix., p. 341).

With regard to this development, Speyer (*Stett. Ent. Zeit.*, xxxviii., p. 40 *et seq.*) notices that the farthest removal from the typical spotting occurs in those species which have lost the pairs of spots as such, and have, in their place, three longitudinal streaks, of which two spring from the base of the wing, whilst the third occupies the discoidal cell, and pushes its narrow basal half between the other two. This is caused by spot 1 lengthening towards the apex to a point, whilst 2 joins with 4 and 3 with 5, whilst 6, if present, is united to 5, and forms the broad base of the central streak, extending over branches 1 and 2 of the median vein. This extension is well shown in *A. purpuralis* (*minos*) and *A. erythrus*, whilst in those species in which the three streaks have been developed from 5 (and not 6) spots, as in *A. scabiosae* and *A. brizae*, this widening is wanting. Speyer further remarks that the development of the streaks from spots can be readily traced in *A. achilleae* and *A. cynarae*, whilst the retrogression of the streaks through partial loss of the red coloration may frequently be traced in *A. scabiosae*, and *A. purpuralis*.

Speyer, however, discovered a form of *A. trifolii*, which he named *trivittata*, from the fact that its markings were characteristically like, and similarly formed to, those of *A. purpuralis*, *i.e.*, spot 1 forms a narrow streak reaching to the middle of the costa ; the middle streak, formed by the union of 5 to 3, is divided from the first by the black subcostal nervure, is rounded at the end, and of equal thickness until halfway to the base, when it narrows to a sharp point between the stems of the subcostal and median nervures ; the lowest streak is formed by 4 joining 2, and is broadest at the end situated in the middle of the wing. This belongs to the small-winged form of this variable species.

An intermediate form, taken at the same place, showed that the middle streak was formed of 3 + 5, by not being straight on its upper margin, and by the presence of a deep indentation between the positions of 3 and 5. The median nervure, too, is dusted with red, so that the middle streak (3 + 5) is united to the lowest one (2 + 4). This specimen, Speyer mentions, has a very broad black border, reaching to the base of the inner margin of the hind-wings, as well as the inner marginal, the median, and two other nervures distinctly blackened. These, he says, are the only specimens of this kind he had come across in *A. trifolii*, although the ordinary blotched forms were commoner with him than the spotted forms.

With regard to the normal variation of *A. trifolii*, Speyer's remarks agree with the generally observed facts. Starting from the five-spotted form, he shows that the blotching takes place as follows: (1) The union of the basal spots, owing to the dividing nervure, becoming red. (2) The middle pair become united (Esp., *Die Schmett.*, pl. xxxiv., fig. 5). (3*a*) The red spreads longitudinally, the basal pair giving out a long-pointed streak, which becomes merged into a similar enlargement which stretches towards it from the middle pair. (3*b*) More rarely the upper part of the middle spot is united with 5 by a narrow bridge, whilst the basal pair is still separate from the middle pair (ab. *glycirrhizae*, Hb.). (4) Lastly, 5 joins with 3 + 4, at first by a narrow bridge, then broadening, until at last the spots comprise a large irregular longitudinal blotch, with two shallow broad depressions on the inner marginal side, which indicate the original divisions of the spots (ab. *confluens*, Stdgr.). The basal pair of spots sometimes remain separate after the blotching between the other spots has commenced. Speyer further points out how remarkable it is that both types of blotching that occur in the Anthrocerids should occur in this one species: (1) The blotching due to the junction of the pairs of spots by longitudinal streaks (ab. *minoides*). (2) The union of the spots into true wedge-shaped marks (ab. *trivittata*).

Referring to the blotching of *A. lonicerae*, we find that Speyer has observed a distinction in the mode of formation compared with that in *A. trifolii*. He observes, that when spots 3, 4 and 5 are united in the former species, they form a large irregular rhomboidal red blotch, whose point (spot 5) is more extended and nearer to the apex than in *A. trifolii*. Compared with *A. trifolii*, blotched specimens of *A. lonicerae* are rare. Treitschke (*Die Schmett. von Europa*, x., p. 105) says that he had never seen *A. lonicerae* with confluent spots. Herrich-Schäffer (*Syst. Bearb.*, ii., p. 36) says: "Spots 3, 4 and 5 are never joined." Most of the British blotched specimens of *A. lonicerae* are reputed to come from the neighbourhood of Coventry. Occasional specimens have also come from York and the neighbourhood of Strood.

The development of peculiar and striking congenital aberrations occasionally takes place in this group. The substitution of an extra wing in the place of the left hind leg, in a specimen of *A. filipendulae*, bred from a cocoon found at Cambridge by Richardson, in 1877, is very interesting. The specimen is a male, of the ordinary colour and markings, the extra wing resembling an ordinary hind-wing of this species in shape and appearance, but is much smaller, being 3‴ in length, and 2‴ in breadth, as compared with the ordinary hind-wing in the same specimen, which is 4½‴ long and 2½‴ broad. The extra wing is much more thinly scaled than the others, is fringed, however, at the margin, and has almost typical neuration. It has a distinct blackish border on the posterior margin of the basal half of the wing; the outer half of the wing being poorly coloured and scaled. The wing is attached to the body along the line in which the first joint of the leg would lie if present; the line of junction is so great (1‴) that the wing must have been quite immovable when the insect was alive; and, although it has one or two slight longitudinal folds, the wing is not in any way deformed. Bateson regards the evidence that a wing was here substituted for a leg inconclusive, as no dissection was carried out, but Richardson considers it improbable that he accidentally broke off a leg (as has been suggested) and states (*in litt.*) that there is no trace of any leg ever having been present. Richardson has another specimen of *A. filipendulae* (from Portland) in which the middle right leg is dwarfed to half its size, suggesting a probable tendency in the same direction.

Rogenhofer describes and figures (*S. B. z.-b. Wien*, xxxii., pp. 34-35) a five-winged specimen of *A. purpuralis*, captured by Bohatsch in July, 1882, at Gräfenberg. This has on the left side, between the two normally developed wings, and directly in front of the frenulum, a third wing, somewhat crippled at its base and about half as large as the normal hind-wing, which it resembles in shape, although having the colouring of the fore-wing. The red is confined to the basal half, the outer portion of the wing being blackish. The neuration is peculiar, the two chief nervures are swollen at the base, run apart, and form no discoidal cell; the median sends out two branches above and two below, and is forked just before the outer margin; the subdorsal and inner-marginal nervures form curves, and run into the middle of the inner margin.

An equally strange aberration occurs in a female specimen of *A. exulans*, captured by Chapman at Oberalp, in August, 1895. In this specimen, the legs and usual wings are quite normal, and in their usual positions, but between the left anterior wing and the mesothoracic leg are two additional winglets. The distance between the wing and the leg seems to be a little greater than usual; at a distance below the wing of about a millimetre, and parallel to it, is a supernumerary wing. Its length is barely a third of that of the wing above it, but, structurally, it represents the basal half of a normal upper wing, all the nervures being present up to nearly the end of the discoidal cell, and the colour of the scales covering it fairly correspond. The costa terminates in a small crumpled process, apparently representing the costal margin of the wing as far as the apex; the rest of the wing terminates abruptly without any definite fringe, which one usually finds on the margin of congenitally abbreviated wings. A second supernumerary wing arises about half a millimetre below the first, still on the mesothorax. It is too defective and crumpled to admit of any certain resolution of its structure, but it presents several folds of wing structure that would, if they could be straightened out, probably show it to be as long as the other supernumerary. It also is clothed with some red scales.

South has described and figured (*Entom.*, xxvii., p. 253) a specimen of *A. trifolii*, captured in Sussex by Christy, on June 18th, 1893, which, on the right side, has the hind-wing entirely absent, whilst on the left side a wing similar in shape, colour and markings to the normal fore-wing replaces the hind-wing. The specimen, therefore, has three normal fore-wings, judged by markings, etc., and no hind-wing. The second wing on the left side appears, so far as can be judged from the figure, to arise from the metathorax and not to be a second mesothoracic wing. Later, South noted (*Ibid.*, p. 294) that the insect had only two pairs of legs, (the mesothoracic), evidently, from the figure, being the missing pair. Capper has a male *A. lonicerae*, bred by Hewett in 1888, from a cocoon obtained near York, with the wings on the right side nearly normal (the hind-wing is somewhat pointed), whilst on the left side, the hind-wing is simply a duplicate of the fore-wing, being almost of equal length, of the same blue-green colour, with crimson spots; the apex is slightly more rounded, and the base of the costal margin more arched than in the fore-wing. Oberthür describes and figures (*Variation Lép.*, p. 53, pl. vii., fig. 123) a specimen of *Anthrocera occitanica*, in which the right hind-wing, in place of being normally red as the left, is spotted exactly as the fore-wing, the contour and neuration also agreeing with the latter. This specimen belonged to Boisduval, who, in 1853, communicated to the Ent. Soc. de France, the fact that it was bred by Daube, from a larva that he had captured.

Barrett (*Lep.*, ii., p. 128) alludes to specimens of *A. trifolii*, found by Christy in West Sussex, in which the wings were incomplete, as though irregularly cut back, so that some had but half wings, and a few were nearly apterous. Some of these specimens had the fore- and hind-wings cut and stalked in a most curious manner. Fletcher has had pairings of deformed males with ordinary females and the reverse, but so far as the limited numbers bred go, the deformity was found not to be hereditary.

Whilst considering these congenital aberrations, we may mention the occasional occurrence of imagines that retain the larval head. Fletcher has such a specimen of *A. filipendulae*, a female, bred from a Deal pupa, in which there is no trace of the antennæ of the imago. Luff reared a specimen of *A. trifolii* on August 11th, 1874, from a pupa obtained at Herm, which still bore the head of the larva. Two similar specimens of *A. lonicerae* are recorded by the writer as being obtained from pupæ, from Mansfield, Notts, and Staudingèr notes the capture of a similar specimen of *A. exulans* at Bossekop, on July 11th, 1860. The latter says that in his example the moth was completely developed except the larval head, the mandibles of which were immovable, and the head fixed to the prothorax and only capable of being moved with the latter. The prothorax was completely metamorphosed and carried imaginal legs. There was no indication of an incompletely developed imaginal head within the larval one.

Bowell has (*Ent. Rec.*, ix., pp. 271-273) some interesting notes on the scales of some of the species of the genus *Anthrocera*. He finds that the species divide into three groups: (1) The "*ephialtes* group," comprising, among others, this species, and *lavandulae*. This group is characterised by there being no difference between the scales of the upper and lower wings. (2) The "*filipendulae* group," comprising, among others, *trifolii*, *lonicerae* and *filipendulae*. This group is characterised by the scales of the hind-wings being more attenuated than those of the fore-wings. The former are generally bifid, the latter bifid or trifid. There is, however, great variation in the scales of some species of this group. (3) The "*minos* group," in which the scales are long ovals, more or less sparsely planted, and rarely bifid. Whenever these scales suggest a triangular shape, the base of the triangle is towards the base of the scale, the reverse being the case in the other groups. *A. viciae* (*meliloti*) is said to form in the structure of its scales a connecting link between the "*filipendulae*" and "*minos*" groups, with more defined affinities with the latter.

The simple scales of the "*minos* group" are supposed to represent the most generalised form. The brilliant red scales are, in all cases, rounded at the tips, and the amount of rotundity seems to determine the brightness of the general appearance. The duller red or orange scales are bifid or trifid. Bowell further remarks that *A. filipendulae*, *A. lonicerae* and *A. trifolii* are, in scale structure, probably the most fixed and typical of the species of the "second" group, and that the external resemblance of the two latter species is not maintained in the scales.

We have already suggested the tendency of the fore-wings of the males of most of our British species to be purple-blue in colour, and the females green. The dark border of the hind-wings is, as a rule, wider in the males than in the females, in the latter sex of *A. filipendulae*, the border is often confined to the fringe alone. The Anthrocerid male is also (in some species, at least) specialised in having two eversible feathery tufts or scent glands, immediately in front of the anal segment, and placed just ventrally thereto.

The antennæ of *Anthrocera* are cylindrical in so far that they have everywhere a smooth, circular, transverse section. The segments become larger and larger as the base is left, so that the well-known club-shape results; there is some variation, in different species, in the sharpness of the decline in size at the tip. Each segment is rather short for its width, but the articulating surface does not occupy the whole of the ends but only a central portion; the opposed faces have neither scales nor sensory hairs. The dorsal surface, from end to end, is covered with scales, and the ventral with sense hairs. The only exception to this that I have noted is that in some species the terminal segment is reddish (free from pigment), and without dorsal scaling. The sensory hairs form a dense velvety coating to the under surface, and have amongst them some larger ones on each segment. The chitinous surface itself, of the ventral aspect, is covered with conical prominences. There are certainly no cones (Bodine's terminology), and I think no pits. The conical prominences noted look like short, thick hairs, about half the length of the others, but I cannot determine that they have any articulation at their base. They are larger and more regular than the serrated points that cover the chitin of the pectinations of *Harrisonia*, but the density of the pigmentation is greater than in that form, and makes observation even more difficult. The dorsal chitin is free from any projection, except the scale-cups, and has no hairs, except one (or more ?) close to the distal margin of the segment, and about the middle of the dorsum. In *Harrisonia*, dorsal hairs amongst the scales are more numerous (Chapman).

The species included in this genus are day-flying insects, generally very local, and usually abundant where they occur. They boom along heavily in the hottest sunshine, or sit, sometimes several on a single flower-head, sucking the nectar from the capitula of *Centaurea* or

Scabiosa, or swarming about the blossoms of a privet bush or *Vicia*. We have repeatedly noticed the habit of "assembling" in *Anthrocera hippocrepidis*, St., *A. lonicerae* and *A. exulans*, sometimes as many as a dozen males buzzing at one time round a newly-emerged female; and Oberländer records the attraction of a number of males of *A. filipendulae* by a cocoon (with pupa), at Rouen in 1879, whilst holding it in his hand. Curiously there is no mention of the sex of the pupa, but there is little doubt it was a ♀, and probably near the point of emergence. The British species are but few in number, yet they are not at all well-known. The earliest species to appear are *A. hippocrepidis*, St., and *A. trifolii* (*-minor*), which fly in pastures and meadows, often with *A. statices*, in late May and early June; *A. lonicerae* occurs in wood-clearings, in middle and late June, and about the same time *A. viciae* (*meliloti*) appears in the rides of the New Forest, about Stubby Coppice. A week later, *A. purpuralis* abounds in its western haunts, whilst, in early July, *A. filipendulae* puts in its appearance, on sea cliffs and coast sand-hills, inland chalk-hills, moors, and waste places, almost everywhere, its flight, however, often extending well into August. In another week or so *A. exulans* is to be found on the alpine moors above Braemar, whilst the last fortnight of the month usually sees *A. palustris* (*trifolii-major*) abundant in its marshy habitat. *A. filipendulae* is by far the most common and most widely-distributed species; *A. hippocrepidis*, St., is, so far as is known, confined to our south-eastern counties; *A. trifolii* is locally abundant, and widely distributed, whilst the same may be said of *A. lonicerae*. *A. palustris* (*trifolii-major*) is very local, and apparently not widely distributed, whilst the other three species are only to be obtained in their known special haunts, or similar ones in likely districts, *A. exulans* in the Scotch Highlands, *A. purpuralis* on the western coasts, and *A. viciae* in the New Forest. Allowance must always be made in the time of appearance for a difference between seasons. In 1888, *A. trifolii* was out in late June and early July, *A. palustris* (*trifolii-major*) in late August, and we saw *A. filipendulae* in late September. In 1893, *A. trifolii* appeared in the middle of May, *A. palustris* (*trifolii-major*) in mid-June, whilst *A. filipendulae* was out in abundance during the latter month. Fletcher considers that, in confinement, if undisturbed, the Anthrocerid larvæ are easy to winter.

ANTHROCERA (MESEMBRYNUS) PURPURALIS, Brünnich.

SYNONYMY.—Species: *Parpuralis*, Brünnich, "Danske Atlas," i., pl. xxx., p. 686 (1763); Müll., "Zool. Dan. Prod.," no. 1345, p. 116 (1776); Auriv., "Nord. Fjär.," p. 53 (1888); Kirby, "Cat. Lep. Het.," p. 63 (1892); "Handbook," etc., p. 87 (1897). *Minos*, ? Den. and Schiff., "Verz. Schmett. Wien," p. 45 (1776); ? Schrank, "Fuessly's Neues Mag.," ii., p. 208 (1785); Hb., "Beitr. Gesch. Schmett.," ii., p. 20 (1790); "Eur. Schmett.," ii., fig. 8, p. 77 (1797); "Verz.," p. 119 (? 1822); Ochs., "Schmett. Eur.," ii., p. 22 (1808); Bdv., "Mon. des Zyg.," p. 29, pl. i., fig. 7 (1829); "Icones," ii., pl. lii., fig. 5, p. 41 (1834); Freyer, "Neuere Beit.," vol. i., p. 156, pl. 86, fig. 1 (*ante* 1833); Dup., "Lép. Fr.," supp. ii., p. 40, pl. iv., fig. 4 (1835); "Stett. Ent. Zeit.," 1844, p. 85; Zell., "Isis," 1840, p. 137; "Stett Ent. Zeit.," 1844, pp. 38-43; Evers., "Fauna Lep. Volg.-Ural.," p. 93 (1844); H.-Sch., "Sys. Bearb.," ii., p. 30 (1840), vi., p. 43 (? 1856); Assmn., "Besch. Schmett. Schles.," ii., p. 7 (1845); Hering, "Stett. Ent. Zeit.," 1846, p. 235; Kayser, "Deutsch. Schmett.," p. 168 (1852-9); Sta., "Man.," i., p. 80 (1857); "Ent. Ann.," 1862, p. 50; "Ent. Ann.," 1866, p. 20; Speyer, "Geog. Verb. Schmett.," i., p. 340 (1858); Hein., "Schmett. Deutsch.," i., p. 155 (1859); Newm., "Zool.," 1861, pp. 7565-6; Dbldy., "Zool.," 1861, p. 7715; Wallgrn., "Skand. Het.," p. 90 (1863); Lucas, "Hist. Nat.," 2nd Ed,, p. 150 (1864); Nolck., "Lep. Fn. Estl.," i., p. 79 (1868); Newm., "Brit. Moths,"

p. 23 (? 1869) ; Staud., “Hor. Soc. Ent. Ross.,” vii., p. 102 (1870, pubd. 1871) ; Kirby, “Eur. Butts.,” etc., p. 88 (1879) ; Frey, “Lep. der Schweiz,” p. 64 (1880) ; Oberth., “Lep. des Pyr.,” p. 27 (1884) ; Barr., “Lep. Brit.,” ii., p. 177 (1894) ; Tutt, “Ent. Record,” vi., pp. 270-276 (1895) ; “Brit. Moths.,” p. 354 (1896). *Pythia*, Fab., “Gen. Ins.,” p. 275 (in part) (1777) ; “Mant.,” ii., p. 101 (1787) ; Amstein, “Fuess. Mag. Ent.,” i., p. 113, pl. i., fig. 6 ; Fuessly, “Ibid.,” p. 140 (1778) ; View., “Tab. Verz.,” i., p. 23 (1789) ; ? Freyer, “Neuere Beit.,” v., p. 152, pl. 473, fig. 1 (1845). *Pilosellae*, Esp., “Die Schmett.,” ii., p. 186, pl. xxiv., figs. 2 a ♂, b ♀ (1781) ; pt. 2, p. 14, pl. xl., figs. 3-6, p. 32, pl. xliv., fig. 10 (1789) ; Bork., “Sys. Besch.,” ii., pp. 25 and 164 (1789) ; “Rhein. Mag.,” i., p. 307 (1793) ; Schrk., “Fauna Boica,” ii., 1st pt., p. 240 (1801) ; Zell., “Stett. Ent. Zeit.,” xxxiii., p. 27 (1872) ; Staud., “Cat.,” p. 45 (1871) ; Curò, “Bull. Soc. Ital.,” vii., p. 194 (1875) ; Sand, “Cat. Lép. Auv.,” p. 22 (1879) ; Peyer., “Cat. Lép. Als.,” p. 47 (1880) ; Hofmn., “Die Gross-Schmett.,” etc., p. 34 (1887) ; “Die Raupen,” etc., p. 35 (1893) ; Meyr., “Handbook,” etc., p. 448 (1895). *Achilleae*, Newm., “Zool.,” p. 7565 (1861). *Nubigena*, Newm., “Zool.,” 1861, pp. 7676-7 ; Birch., “Ent. Mo. Mag.,” iii., p. 33 (1866) ; Kirby, “Eur. Butts.,” etc., p. 88 (1879) ; Buckler, “Larvæ,” etc., ii., p. 9 (1887).

The synonymy of this species is most complicated. Brünnich, in 1761, described this species without a name in the *Prodromus Insectologiae Siaellandicae*, p. 29. In 1763, he figured the species in Pontoppidan's *Danske Atlas*, i., pl. xxx., naming it *purpuralis*, and referred the name to the previous description, which, therefore, became the original diagnosis of the species. The reference in Pontoppidan's work reads : “7. *Purpuralis*, described in *Prodromus Ins. Siaellandicae*, p. 29, no. 18 ; and, see also the present work, pl. xxx.” This name, therefore, long antedates the names of *minos*, *pythia* and *pilosellae*, the synonymy of which we have already fully discussed at length, *Ent. Rec.*, vi., pp. 270-276.

Original description.—The description to which Brünnich refers his figure of *purpuralis* in the *Danske Atlas* is as follows : “*Sphinx*. Statura *Sphingis filipendulae*, lingua spirali, alis superioribus cyaneis, lineis tribus rubris in singula ala, una nempe a basi alæ partem marginis exterioris facit, altera longior etiam a basi medium tenet, tertia incipit inter has duas, paulo ante quam finitur prima, et progreditur dilatata, non vero ad extremitatem alæ. Alæ inferiores rubræ immaculatæ [Brünnich, *Prodromus Insectologiae Siaellandicae*, p. 29 (dated April 23rd, MCCLXI in error for MDCCLXI).]

Imago.—Anterior wings bluish-green with three longitudinal crimson dashes, one, wedge-shaped, running from the base of the wing along the costa, the second, from the base to the centre of the wing, the third from the centre of the wing towards the apex and outer margin. Posterior wings crimson, with a narrow purplish hind marginal line.

Sexual dimorphism.—The sexes are, as a rule, very similar. The males vary in size from 23 mm. to 34 mm., the females from 25 mm. to 36 mm., in some 60 specimens examined, the average female being larger than the male. There appears also a tendency for the female to be more thinly scaled, and it is certain that this sex has the red much more often continuously spread over the central area of the fore-wing than has the male. Boisduval notices that the apex of the hind-wings is usually dark grey in the males, but rarely so in the females. In many males the dark grey border is twice as broad as the cilia of the hind-wings, and is continued, though very narrowly, as far as the third branch of the median nervure. Occasionally it is three times as broad as the cilia, and its continuation along the hind margin is broad in proportion. Borkhausen notices that the ground colour of the males often has a blue tint, that of the females being light green, Variation.—More perhaps has been published on the variation of this, than any other Anthrocerid, species. It is not confined to any particular kind of habitat, nor to one condition of environment, except that it is rarely (if ever) found off a calcareous soil, and flourishes in the plains of Central Europe, the warm valleys of southern Europe and the high Alps to 9,000 ft. It extends from Sicily to the Arctic Circle, and from the west shores of Ireland to the borders of China. In many places it is a roadside species, in others it haunts grassy openings in woods, in others, exposed hillsides, and yet again is found high on Alpine pastures. Under such varied conditions it is not surprising that the species should exhibit considerable variation, and much difficulty has existed as to the determination whether certain forms were races of this, or really distinct, species. The scales are readily removed, but the diaphanous appearance of some individuals is not altogether due to their being somewhat worn. There is, however, considerable variation in the size, as well as in the intensity of the coloration of the red blotches of the fore-wings, and, frequently, there is a tendency for the blotches to decompose into the spots characteristic of the "spotted" groups. Zeller described (*Isis*, 1840, p. 137) a series of forms illustrating this phase of variation: (*a*) With 1 filling up the space between the costa and subcostal nervure, 2 + 4, entirely confluent, forming a spot anteriorly rounded, and filling up the space between median and subcostal nervures, 3 + 5 + 6 united to form a third spot, pointed towards the base and much expanded anteriorly. (*b*) With the spot 2 + 4 more or less deeply emarginate on both sides. (*c*) With the spot 3 + 5 slightly excavated on both sides. (*d*) With the excavation between 2 and 4 deepened so that the spots are separate, 4 forming a small spot or point towards the base of 2. (*e*) With the excavation between 3 + 5 deepened, so that they become separated. (*f*) Like *b*, but with a short, faint, red streak between the subdorsal nervure and inner margin. (*g*) With the usually dark nervures of the type form covered with red scales, so that the red blotches are entirely united into a single red blotch = the passage to *polygalae*, Esp. Zeller adds that there are connecting links between these aberrations in which, on one or both wings, spots 3 and 5, 2 and 4 are connected by a slender thread of red. He also notes that the forms *d* and *e* do not show half as much red on the fore-wings as the typical form *a* does. Nearly all the specimens of the forms *b*, *c*, *d* and *e* have on the hinder margin of the united last pair of spots, a deep excavation, and the margin is not gradually lost in the ground colour. The portion which belongs to the upper spot, 5, is always of a much deeper red. Other specimens of the form *b* are without this emargination of the securiform spot. On the other hand, in some examples the red scales cover the nervures, and make the central portion of the fore-wings entirely red, occasionally extending even to the inner margin at the base. Freyer notes (*Stett. Ent. Zeit.*, 1844, p. 85) that the securiform spot varies, being broader, larger, and more lost in the ground colour in some specimens than others. All authors are agreed that the south European specimens are as a rule more thickly scaled than those of more northern latitudes and high altitudes. Herrich-Schäffer says that the southern and Alpine examples have frequently a more shaggy-haired abdomen, which conceals the shorter steel-blue scales, This author's fig. 14 shows a specimen in which the securiform spot is hardly expanded behind; fig. 13 shows a very rounded exterior edge to the securiform spot; fig. 15, a female in which the red is much expanded; fig. 16, the securiform spot is much attenuated towards the base. He also observes that the apex of the hind-wing in the male has sometimes a rather broad tinge of black. In his vol. vi. (appendix to vol. ii.), p. 43, he describes a form with the costa red for three-fourths of its length, and then united with a very large but ill-defined spot 5. The latter is united with the enlarged, but otherwise indistinct, spot 4, which is only united with 2 along the middle nervure on which alone 3 is joined to 5. Treitschke describes three forms: (1) Alarum anticarum macula exteriori interrupta. (2) Maculis confluentibus permagnis. (3) Collari humerisque flavescentibus. A difference in the scaling of specimens from various localities is possibly sometimes due to the development of the scales under abnormal conditions, owing to the pupa being badly placed, or it may be only a result of difference of nutrition in the larval stage, a factor, probably, which is also frequently responsible for the difference of size observable. The smallest specimens occur on stony waste places, or dry, hot, rocky slopes, on which the herbage is comparatively sparse and stunted. In the amount of separation between the red blotches, there is also considerable variation. Those specimens in the British Museum collection, in which the red blotches themselves form comparatively thin streaks, are referred to ab. *interrupta*, Stdgr. Nolcken remarks that the specimens from the Russian Baltic provinces vary in size, shape, thickness of antennal club, denseness of scaling, and markings. He notes that in the most extreme aberrations the 4 red spots nearest the base are entirely separate from one another, while 5 and 6 are confluent across nervure 5, but this form is united with the type by many transitional aberrations. An example of this extreme form came from Koervast (Oesel I.) on June 24th, 1848. He further remarks that the specimens from the Russian Baltic provinces differ from German specimens in that the spots 5 and 6 are situated considerably further from the outer margin, whilst the middle cell is more filled in with red scales, no specimens like Hübner's fig. 8, which has much more pointed antennal clubs, being obtained. Oberthür notes that the specimens from Cauterets (Pyrenees) are superb, large, and brightly coloured, somewhat similar to those found at Zermatt, whilst the form from Ariège is smaller and more vermilion than that from Cauterets. One would expect the French specimens from Pont-de-l'Arche (in the Dept. Eure) and Rouen to be very similar to our British examples, and probably this is so. Dupont notes that in them the red blotch 3 + 5 extends usually towards the outer edge of the fore-wings, whilst some examples appear to belong to the ab. *interrupta*, Staud. So far as we have been able to compare them, the Welsh and Irish examples are rather brighter than Scotch ones from Oban, for which we are indebted to Mr. Sheldon. The Welsh specimens we have vary from 23-27 mm., the Scotch from 25-27 mm., whilst the Irish vary from 23-32 mm., more examples of the latter being examined. Boisduval says that the Sicilian specimens are generally larger than those from other parts of Europe, and the females more yellowish. Mathew found the Turkish (Gallipoli) examples measuring, on an average, a quarter of an inch more than Irish specimens. Staudinger records specimens from the Ala Tau, in Central Asia, of quite the ordinary European form. We would call the aberration in which spots 3 and 5, and 2 and 4, tend to be separated, ab. *separata*, n. ab.

The following appear to be the principal local races and aberrations that have so far been described:—

1. With the three blotches narrow and ill-developed = ab. (et var.) *interrupta*, Staud.
2. With the three blotches well-developed, but separated by strongly defined nervures = *purpuralis*, Brün., *pythia*, Fab., *pilosellae*, Esp., *nubigena*, Newman.
3. The blotches like the type, but the specimens rather smaller = var. *graeca*, Staud. (? MS. name only).
4. Also rather small, and the outer spot not dilated, but wedge-shaped = ab. *pluto*, Ochs.
5. Typical, but with the ordinary red areas of a yellow tint = ab. *lutescens*, n. ab.
6. The outer spot large, reaches well towards the outer margin; outer margin more convex; the antennæ more attenuated from club towards base = var. *heringi*, Zell.
7. With the three blotches united, but with distinct dark outer and inner marginal areas to forewings = ab. *polygalae*, Esp.
8. With the fore-wings almost entirely coppery-red, no differentiation into three spots, a narrow outer margin only = ? ab. *rubicundus*, Hb.
9. Thinly scaled, the normal red coloration of a pale crimson = var. *nubigena*, Led.
10. More thinly scaled than 9, red colour duller, the outer wedge-shaped spot broadened outwardly, the two basal spots united in ♀ = var. *diaphana*, Staud.
11. All the normally red markings suffused with blackish = ab. *obscura*, n. ab.

α. ab. *interrupta*, Staud., "Cat. Lep. Eur.," p. 45 (1871).—Macula media latius interrupta.

The specimens in the British Museum collection bearing this name have comparatively thin streaks, and, therefore, exhibit a preponderance of the ground colour, in other words, the red streaks are separated very markedly by unusually broad lines of the darker ground-colour. It has been recorded from Trafoi (Staudinger), Gadmen (Rätzer), not rare in South Sweden (Aurivillius), Freiburg and Weinheim (Reutti), with the type nr. Pont-de-l'Arche and Rouen (Dupont), occurs at Abersoch and in Galway (Tutt).

β. var. *graeca*, Staud. (? MS. name only); Tutt, "Ent. Rec.," v., p. 273.—Specimens occurred on the Parnassus, in the second half of June, also on the Veluchi. Since this common species varies somewhat everywhere, both in the larval and imaginal states, one cannot look upon the Greek specimens as distinct, and less so since they vary *inter se*. I find, however, that the blue-black of the fore-wings in the Greek females, has generally a strong tendency to whitish (*Horae Soc. Ent. Ross.*, vii., p. 102).

Judging from the specimens in the British Museum collection, var. *graeca* is small, but otherwise almost typical in appearance.

γ. ab. *lutescens*, n. ab.—The ordinary red spots of the fore-wings, and the red portion of the hind-wings, yellow in colour. This aberration is very rare. Allen records a specimen from Galway (*vide*, *Ent. Record*, etc., v., p. 217).

δ. ab. *pluto*, Ochs., "Die Schmett.," ii., p. 26; Bdv., "Icones," ii., p. 40, pl. lii., fig. 4 (1834); Dup., "Lép. France," p. 38, pl. iv., fig. 3 (1835).—Alis anticis cyaneis, aut virescentibus, maculis tribus elongatis rubris posteriore cuneiformi: posticis rubris, margine nigricante. It is to be distinguished from *Z. minos* by its somewhat smaller size, the clubs of the antennæ are less thickened, the wings more rounded and broader on the outer margin. The ground colour is darker, it may even be black-blue or green; the red spots are finer, the third is wedge-shaped and shorter, fading off towards the outside into the ground colour. The black border of the hind-wings broadens at the angle. The female is greenish, and has a white-grey border to the shoulder crests. Otherwise it resembles *Z. minos*. It is found in Hungary and the neighbourhood of Vienna.

Staudinger diagnoses this as "minor, macula media extremis non dilatata, alæ posteriores margine nigro (in apice) latiore." It is given as a "south-east European" form by Staudinger, but it certainly exists as an aberration in other parts of Europe. It is the form in which the outer spot is wedge-shaped, and cut off rather sharply towards its outer edge. Keferstein considers (*Stett. Ent. Zeit.*, ii., p. 117) *A. pluto* as a form of *A. minos*, and states that they occur together, but notes that the former has a broader grey margin to the posterior wings. Zeller, writing of one of Keferstein's specimens, and two others received from Vienna, notes the former as having the hind-margin of the anterior wings externally more convex than in *A. minos*. He further remarks that in all, the middle spot of the fore-wings is much farther from the hinder margin, and appears abbreviated; the posterior wings with a broader grey margin. The former of these characters is striking, since the spot reaches little beyond the transverse nervure, then suddenly expands on both sides, projects a tooth obliquely over the third branch of the median nervure, and has its hinder margin not hollowed. He, however, is doubtful as to the specimens being *pluto*, Ochs. Ochsenheimer speaks of a less thickened antennal club, and more rounded and broader wings. Boisduval states (*Monog. des Zyg.*, p. 32) that the intermediate spot in *pluto* is cuneiform, and that this is the only character which distinguishes it from *minos*, in which it is securiform. He afterwards figures (*Icones*, pl. lii., fig. 4) an ordinary *A. purpuralis* as *A. pluto*. Curò gives Liguria and Piedmont only for this form in Italy. Mengelbir captured specimens in the Engadine as high as the tree limit, near Bergell and Lake Como, which were pale in colour, the outer spot cut off somewhat externally and smaller than the type, and these are referred by him to var. *pluto*. Kirby treats (*Cat.*, p. 63) *pluto*, Ochs., as a distinct species.

ε. var. *heringi*, Zell., "Stett. Ent. Zeit.," v., p. 42 (1844).—The middle spot of the anterior wings expands suddenly very considerably, fills up nearly the whole breadth of the space between the first and second branches of the median nervure, is rounded, and reaches even further towards the hind margin than in *Z. minos*. The hind margin of the anterior wings is externally convex, with the convexity most pronounced below the middle, whereby not only the apex of the wing is kept somewhat back, but also the breadth of the wing appears more considerable. The antennæ (especially noticeable in the male) more attenuated from the club towards the base, and in the female are longer and have a more slender club. The males have a little grey at the apex of the posterior wings, the females none at all. Larvæ orange-yellow, on *Thymus serpyllum*, at Stettin.

Hering, as late as 1881 (*Stett. Ent. Zeit.*, xlii., p. 133), insisted on the distinctness of this insect from *A. purpuralis*. He says that they never occur at the same time, generally in different places, and have different larvæ, the larva of *heringi* feeding exclusively on *Thymus serpyllum*, at Damm, Tantow, Vogelsang, etc., in July, the imago appearing in August.

ζ. ab. *polygalae*, Esp., "Die Schmett.," ii., p. 222, pl. xxxiv., contd. ix., fig. 3. —Alis rubicundis concoloribus, limbo sinuato superiorum atro caerulescente. First discovered in the summer of 1780, in the neighbourhood of Brauenheim, the specimen figured having come from Herr Gerning. Closely related to *Sphinx pilosellae*, of which it has been suggested that it is a variety, but, plentiful as is the latter in Franconia, no similar specimen has been found there. In *S. pilosellae* the scaling is very thin, in *S. polygalae* it is very thick, and on both sides of the wings the latter is unicolorous red.

Esper's figure of *polygalae* differs from Hübner's figure of *rubicundus*, in that the colour is crimson, not coppery, and that there is a broader border on the inner margin which is absent in *rubicundus*. Staudinger diagnoses it as "maculis confluentibus." Lederer notes (*Verh. zool.-bot. Ver. Wien*, ii., p. 93) that Heydenreich unites *polygalae* and *rubicundus*, but avers that this cannot be correct, since Esper gives Brauenheim, nr. Frankfort, as the locality for the former, whilst the latter occurs only in Romagna and Asia Minor. He considers it as nearer Zeller's *heringi*, since it is described as of a fiery red colour in contrast to the thin scaling of *pilosellae*. This is scarcely so, and *polygalae* and *rubicundus* both appear to represent the form in which the normally dividing nervures have become covered with red scales, the latter only having the red more extended than the former, although Standfuss considers the latter a distinct species. Curò says it occurs with the type in Sicily. The Swiss localities are the Valais and Bechburg (Stehlin), Killias, near Tarasp (Christ), rare in South Sweden (Aurivillius), Weinheim in Baden (Reutti). [*Vide* also Staudinger, *infra*, p. 437.]

η. ? var. *rubicundus*, Hb., "Samm. Eur. Schmett.," ii., fig. 137 (without description) (? 1818).—The fore-wings are of an uniform fiery vermilion, inclining to coppery-red, with rather more crimson hind-wings, a narrow greenish border only along the outer margin of both fore- and hind-wings.

Staudinger diagnoses (*Cat.*, p. 45) this form (or species) as: "Alis anticis totis sanguineis, margine anteriore angusto cyaneo. Central Italy." He refers *erythrus*, Dup. (*Lép. France*, supp. ii., pl. iv., fig. 1), to this form. Curò notes it as moderately common in the central (Romagna), and more common in the southern (Neapolitan), provinces of Italy, and of doubtful occurrence in Sicily. Standfuss, from specimens received from Calberla, redescribes (*Stett. Ent. Zeit.*, xlv., p. 207) this as a good species: "Alis anticis rubris, margine costali versus apicem margineque exteriore cyaneis (♀ colore pallidiore atque partibus alarum anticarum rubris flavo marginatis); posticis rubris ciliis cyaneo-griseis. Capite, thorace, ano griseo pilosis, palpis pedibusque stramineis. Exp. alar. 30-32 mm. 6 ♂, 6 ♀. Patria: Italia centralis, regiones montanæ 4-5,000 ft." He then adds that the species agrees in wing-form with *A. purpuralis*, the red similar to very brilliantly coloured examples of the same, the antennæ similar to those of that species, but not so strongly thickened before the tip; Hübner, he asserts, figures a ♀, unmistakable from the yellow tinge into which the red shades off; to this the *erythrus*, Bdv. (*Mon. Zyg.*, p. 28, pl. i., fig. 6) is to be referred. (Boisduval cites as a synonym of his *erythrus*, Hübner's, pl. xviii., fig. 8, which he contradicts later, *Icones*, ii., p. 36, pl. lii., fig. 1.) Standfuss says that it appears to be a purely mountain species, and not variable; Calberla took the specimens flying with *A. pilosellae* var. *nubigena*, and a striking grey form of *A. achilleae*. Staudinger challenged (*Berl. Ent. Zeits.*, xxxi., p. 32) these conclusions, stating that *erythrus*, Bdv. (*Mon. Zyg.*, pl. i., fig. 6), appeared to him entirely different from Hübner's fig. 137, and that the whitish colour on the thorax, etc., which Standfuss relied upon as distinguishing *rubicundus*, was equally strongly marked in undoubted ♀ *pilosellae*, from Amasia, and even more strongly white-haired than the Sicilian *erythrus*, Hb., and the *rubicundus* caught by Standfuss in the Abruzza. Standfuss, in reply, figured (*Ibid.*, xxxii., pp. 237-238) the genitalia of *rubicundus*, the red form of *purpuralis* (= *polygalae*) and *punctum*, from which it would appear that his *rubicundus* is perfectly distinct from *purpuralis*. One would like to know though what differences exist between the genitalia of *rubicundus*, Standfuss, and *erythrus*, Hb.

θ. ab. (et var.) *nubigena*, Led., "Verh. zool.-bot. Ver. Wien," ii., p. 93 (1852).—Very thinly scaled (like *A. exulans*), the red of a pale crimson, the border of the hindwings rather convex.

Lederer calls this Alpine form *nubigena*, Mann (MS. name), and describes it from a single male specimen from the Pasterze glacier. This must not be confused with the Irish form, *nubigena*, Birchall, which is very near, if not identical, with the type. We have taken the mountain form on the high Alps in many localities—Mont de la Saxe, 7,000 ft.; above Cogne, 6,500 ft.; Petit St. Bernard, 5,500 ft.; Le Lautaret, 8,000 ft., etc.,— and find the specimens large, rather thinly scaled, and distinctly pale in colour. They differ much from the Irish specimens, which, in good condition, appear to be identical with the continental type, except perhaps that they are rather less in average size. Curò records *nubigena*, Led., from the Italian Alps, Jordis as occurring on the Simplon. Frey says that, "all who have observed this species on the Alps well know that there is no sharp line of demarcation between the type and var. *nubigena*, *i.e.*, such specimens as Mann obtained at Gross Glockner. I have such specimens, captured in 1865, in the Upper Engadine, a thousand feet above Sils-Maria, where *nubigena* occurs as a large, thickly-scaled and dark-coloured insect." Staudinger records it as being found on the pastures up to 7,000 ft. at Heiligenblut, in Carinthia; whilst Erschoff records this form from the defile of Chakhisnarden, in the Pamirs, and Fedchenko, from the Kokand district, from 4,500-7000 ft.

ι. var. *diaphana*, Staud., "Berl. Ent. Zeit.," xxxi., p. 31 (1887).—About 80 specimens received from Manissadjian, collected at Hadjin, in central Southern Asia Minor, in the middle of May. This var. comes very near the Alpine form, *nubigena*, Led., and is somewhat smaller than typical *pilosellae*, and thinner scaled even than var. *nubigena*. It differs especially from var. *nubigena* in the outer wedge-shaped spot being more broadened outwardly, which in specimens of *nubigena* (from Lederer's collection) is less broadened externally than in *A. pilosellae*. The wedge spot is the broadest in female *diaphana*, in which also the other two red stripes are larger, and confluent almost as in the ab. *polygalae*, Esper. The red markings are also much duller and more transparent in *diaphana* than in *nubigena*. [The var. *polygalae* I also obtained in abundance from Manissadjian from Malatea, where it was captured in the middle of May. In these Malatian specimens, the whole fore-wings, with the exception of only a narrow outer, and the inner, margin, are often of a much brighter and deeper red than that of *diaphana*. Such specimens much remind one of the Italian *rubicundus*, Hb., which, indeed, according to Dr. Standfuss (*Stett. Ent. Zeit.*, 1884, p. 207) is a good species. *Erythrus*, Bdv. (*Mon. Zyg.*, pl. i., fig. 6), which Standfuss refers, without hesitation, to *rubicundus*, Hb., fig. 137, chiefly on account of the white hairs on the thorax, appears to me to be quite different from *rubicundus*, Hb., fig. 137, and I possess also undoubted female *A. pilosellae* from Amasia, which are even more strongly white-haired than the Sicilian *erythrus*, and the specimens caught by Standfuss, at Abruzza, which he refers to *rubicundus*, Hb. I consider that much more material is needed before the matter can be cleared up.]

κ. ab. *obscura*, n. ab.—The upper, and, in a less degree, the lower, wings much suffused with black, and but faint red markings visible. These dusky examples were captured in Carnarvonshire, in 1891, by Blagg (Weir, *Proc. Ent. Soc. Lond.*, 1891, p. xxxi).

This appears to be a somewhat parallel form to *A. filipendulae* ab. *chrysanthemi*. For the phenomenon presented by these dusky forms, that are not strictly melanic, Weir suggested the term "phæism."

Ovum.—The egg is distinctly oval in outline, with a small oval depression on the upper surface, length : breadth : : 5 : 4, uniformly pale yellow in colour, one pole not noticed to be transparent (probably too old). The egg slightly shining, the surface slightly pitted, one pole, however, being much more distinctly pitted. When laid in heaps (attached to each other) they are very irregular in outline. [Eggs laid August 4th, 1898, described August 8th, with a two-thirds, used as a hand, lens.] Esper notes the eggs as "laid upon each other in heaps; in shape and colour not unlike those of *S. filipendulae*; the larvæ hatched after 14 days, and fed for a few weeks; they then hybernated." We can confirm the statement that the eggs are laid in heaps, two (sometimes three) layers in thickness. The empty eggshell is quite transparent, and by far the most pitted of all the allied species, the pittings taking the form of a very distinct polygonal reticulation. The embryo usually escapes from the micropylar end, but occasionally (when the micropyle is covered by an overlapping egg) from the side.

Habits of larva.—A female, received from Chapman in early July, 1897, had laid batches of eggs on the upper leaves of trefoil, and the young larvæ from these spun considerable loose, flossy web over the stems and leaves, and had eaten little patches out of the upper surfaces of the leaf, leaving, however, in many cases, the under epidermis untouched. Buckler states that eggs of this species in his possession, hatched on July 10th, that the young larvæ fed on *Thymus serpyllum*, and refused *Pimpinella saxifraga*, that they grew very slowly, were no bigger than a leaf of wild thyme, and much like it in outline, when they settled down for hybernation in the beginning of September. They assembled in two little groups for this purpose, spinning some silk on the underside of the stoutest stems of their food-plant to rest upon, and remained there until the end of February. During this time it was difficult to distinguish them from a withered thyme-leaf, so similar were they in colour, and furnished with little hairs of the same length. Throughout their growth the larvæ moved and fed with most energy in the sunshine. In moulting, Buckler remarks that the skin splits all along the back, as in *A. trifolii*. Dorfmeister says that the larvæ hybernate twice, and take two years to attain their full growth. This is probably only true for a certain number.

Larva.—Hübner says (*Beit.*, ii., pt. 1, p. 21) that the larva is like that of *A. scabiosae*, but is pale yellow (not golden-yellow, as in that species), with two rows of twelve black spots in each. Borkhausen, however, states that he has found the larvæ commonly, that they are "of the size and form of the larva of *S. peucedani*, bluish-white or pale yellow in colour; the head small and black; a row of black dots on either side of the body, and beneath these a row of bright yellow tubercles; the spiracles are black; the whole of the body covered with white hairs." Boisduval also notes that the larva is much like that of *A. scabiosae*. He describes it as pubescent, pale yellow in colour, sometimes greenish, its head and true legs blackish, with two lateral rows of twelve black spots on either side. Oberthür diagnoses the larva as green with a double dorsal row of black points, the green hue agreeing with Buckler's observations on larvæ of the Irish form. Zeller, Hering and Freyer all appear to be conversant with two forms (referred to at length later): (1) Whitish or bluish-white, with no distinct dorsal stripe. (2). Orange-yellow, with dark dorsal stripe. The former is supposed to produce the normal continental form, the latter Zeller's *heringi*. Hering describes (*Stett. Ent. Zeit.*, 1846, p. 235), the larva of the latter as "dark citron-yellow; at the end of each segment are two black spots, which consequently form a double row of spots, between which are numerous white hairs, placed on extremely fine blackish warts. Above the legs is placed, in the middle of each segment, a small black spiracle, over and under which are white hairs, as on the back." Millière describes the larva in its *fourth instar* (*i.e.*, in spring, directly after its third moult, when it is very different from the larva in its fifth instar) as being entirely of a deep green colour, nearly black, except that the prothorax is greenish-grey, and the segments from 3-9 carry an oval spot of citron-yellow colour surmounted by deep black. He considers the *full-fed* larva to be well figured by Boisduval, Rambur and Graslin. Buckler described the larvæ directly *after they had finished hybernation* as being "one-sixth of an inch in length, in colour pinkish-brown all over, some faint traces of subdorsal rows of black and yellow spots, the hairs arranged in little tufts. After moulting (March 14th), the colour was of a dull, blackish, rifle-green, the upper spots showing like black velvet, and the lower row being distinct, and of a primrose-yellow colour; some of the hairs were black, others whitish. The larvæ became lighter as they increased in size, and on April 1st moulted again, coming out almost black, but becoming paler as they grew, until they were dark olive-green. They moulted again on April 15th, and appeared darker than before. They were *full-fed* about the end of April, and were then described as being of the usual fat, soft, Anthrocerid figure, measuring three-fourths of an inch when in motion, but only five-eighths when at rest. The colour all over was a rich dark olive-green; the dorsal line was dirty whitish, showing broadest and palest at the commencement of each segment; on each side of it was a row of eleven black velvety round dots placed on the front of each segment from the third (mesothoracic) to the 13th (9th abdominal). Below this was a row of eight yellow spots, commencing on the fourth (metathoracic), and ending on the 11th (7th abdominal) segment. The spots were placed on the hinder part of each of these segments, in such a way that the yellow spot of each came just below the black dot of the segment behind it. The spiracles were black, the belly rather paler than the back, the usual dots were not visible, but each segment bore, in a transverse row, eight fascicles of stiff white hairs, five or six in a fascicle." For a summary of the different descriptions of the larva of this species, Buckler (*Larvae Brit. Moths*, ii., p. 12) should be consulted.

Variation of larvæ.—Borkhausen is the first author who notices the variation of this larva, and he states that he found it commonly, bluish-white and pale yellow forms being equally abundant. Hering, in 1843, found whitish larvæ of this species feeding on *Pimpinella saxifraga*, in the fortification trenches at Stettin. A month later, in a plantation, on dry sand, he found a number of orange-yellow larvæ on *Thymus serpyllum*. (It was the moths from these latter that Zeller named *heringi*.) Zeller himself had previously found whitish larvæ on *Pimpinella*, and yellow larvæ on *Thymus*, in dry sandy places, but he detected no difference in the resulting imagines. Freyer figured (pl. 86) a yellow form of the larva as that of this species, and until May 25th, 1843, had found no larvæ of any other colour. On that date he found, in a meadow near a wood, a number of the whitish form of the larva, which is very like Hübner's figure, and at the same place some yellow larvæ with them. They ate only *Pimpinella*, but bit thyme and other plants. The white and yellow larvæ were kept separately, and whilst the former furnished mostly males, the latter produced mostly females. He further observes that the yellow larvæ had a dark dorsal stripe, whereas on the white or whitish-blue larvæ no dorsal stripe was perceptible. Hering, in 1846, discriminates between these two forms, and states that the whitish larvæ found on *Pimpinella* never occur later than about the middle of May, the yellow larvæ (of var. *heringi*) are found in June.

Cocoon.—Hübner describes the cocoon as "yellowish, very shiny," Wilde as "convex, of a brownish-yellow colour." Borkhausen calls it "a cylindrical, straw-yellow, parchment-like cocoon," whilst it is, according to Boisduval, "fusiform, much elongated, of a brownish-yellow colour, found on *Trifolium montanum*," etc. Oberthür describes the cocoon as "oval, opaque, of a white that is slightly yellowish in colour, and shiny." Birchall states that the cocoon is concealed near the surface of the ground, often attached to a stone, but never elevated on the stem of a plant like the cocoons of the other British Anthrocerids. Blagg says that the cocoon is hidden deep down among the stems of heather and grass, and sometimes fastened to stones. The cocoons formed by Freyer's "yellow" larvæ (referred to in the preceding paragraph) were silvery-grey in colour, some few, however, were pale yellow. The cocoons of the "white" larvæ were also much flatter, and not so vaulted as those of the "yellow" larvæ. Buckler's larvæ spun cocoons on the glass cylinder in which they were confined, and not on their food-plant. They were of a glistening, dirty white colour, shorter and more truncate than the cocoons of *A. trifolii.* When the imago emerges, the pupa-case is not left sticking out of the cocoon, but falls down near it.

Pupa.—Hübner notes the pupa as "black-brown on the wing-sheaths, and thorax; the remaining parts yellowish." Wilde says "blackish-brown, abdomen yellowish." Borkhausen remarks that the pupa "is light yellow, with light brown wing-covers," and that "the pupal stage lasts three weeks." Freyer says that the pupæ he examined were very soft, some yellowish-brown, some black-brown, others altogether black. Buckler describes the pupa as brown, with the wing-cases rather darker than the body, and observes that different individuals varied in depth of tint. Barrett describes the pupa as rather short, thick, with head, wing-sheaths, leg-sheaths, and back, black-brown; abdominal segments yellowish.

Food-plants.—*Trifolium, Veronica officinalis, Briza minor, Cynosurus cristatus, Genista tinctoria, Thymus serpyllum* (Borkhausen), *Pimpinella saxifraga* (Hering), *Trifolium montanum, Lotus corniculatus, Hippocrepis comosa*, and other leguminous plants (Boisduval), *Eryngium campestre* (Millière). [? *Polygala vulgaris* (Barrett)].

Parasites.—The larvæ are badly infested with *Gordii* (Freyer).

Habits and habitat.—This species was first recorded as British by Newman (*Zoologist*, 1854, p. 4180), who stated that about a dozen specimens had been taken the previous summer on the west coast of Ireland, by Milner. In June, 1854, More sent specimens for distribution among the members of the Entomological Society of London. These were captured at Ardrahan, and More states that "the *Anthrocera* is quite plentiful about here. It appears about a fortnight earlier than *A. filipendulae.* I first captured it in 1851. . . . . I believe

Milner's locality was in co. Clare, mine is in co. Galway, which shows that the range of the species may be somewhat extensive in these parts." Birchall says that "it is found on the barren terraces of limestone, which form the surface of wide districts in south-western Galway and Clare. The vegetation is merely what springs from the cracks and fissures of the rocky pavement. Here *A. purpuralis* (*nubigena*) appears at the end of June in amazing numbers. When at its height, the air seems as if alive with red bees. Every flower, and almost every stem of grass, has its occupant, and dozens are on every patch of thyme." Wright says that between Kinvara and Ardrahan the species occurred in a large field overgrown with *Arctostaphylos uva-ursi*, *Dryas octopetala*, *Sesleria caerulea*, *Gentiana verna*, and other plants. Walker describes it as occurring in a rough heathy field, at Claring Park (twelve miles from Galway); he also notes it as abundant in a rough heathy field in Merlin Park, in the middle of June, 1880. On the Clare coast, at the end of June, the Hon. Miss E. Lawless says that she could not have believed the incredible numbers in which this species occurred. At Black Head, on the horizontal limestone slabs at the very edge of the cliffs, where nothing grows but a few stunted tussocks of grass and the rare *Adiantum capillus-veneris*, *Saxifraga hypnoides* and *Geranium sanguineum*, *A. purpuralis* (*nubigena*) occurs in such countless thousands that, when she passed her net along the edge of the cliff it came back full of them. Kane says that the Burren district of Clare is a stony bare highland of great extent, and over it *A. purpuralis* is spread, the species extending all over the stony tracts of that northern part of co. Clare. Where co. Clare and co. Galway join, to the south of Galway, the physical and botanical features are so exactly similar that they form really only one district. Oldham says that at Abersoch, in Carnarvonshire, he found *A. purpuralis* on the sunny slopes above the cliffs in hundreds, flying just above the ground in the bright sunshine. He further writes: It was in 1887 that I first saw this species, at Abersoch, and I have visited the place several times since. I have seen them in hundreds, whenever I have been there at the end of May or beginning of June. In June, 1896, I captured from 20 to 30 in five minutes, without a net, so sluggish is their flight (*in litt.*). Near Oban, Sheldon found it about a mile inland, flying along the sides of a rocky valley, 300-400 ft. above the sea-level. The species has no coast proclivity on the Continent. It is often a wayside species in the lower Alpine valleys, as at Bourg St. Maurice. We have taken it on the exposed slopes of Mont de la Saxe (Piedmont) in the greatest profusion, at a height of nearly 7,000 feet, and also at Le Lautaret (Dauphiné), at a much higher elevation. Frequently, as at Courmayeur, it prefers the shady recesses on the outskirts of the pine woods. In the Austrian Tyrol (Mendel) it affects the high alpine fields. Its marvellous abundance in the neighbourhood of Gallipoli, Turkey, in 1878, is described by Mathew, who found it (with *A. punctum*) so abundant on the flower-heads of various kinds of thistles, that there was positively no room for any other insects, and they would not budge an inch, although a score of *Pyrameis cardui* might be fluttering around them. Finot says that, at Fontainebleau, it affects grassy fields behind the château, but, like almost all other Anthrocerids, this species has its years of plenty and scarcity. Speyer notices that its years of abundance are very irregular in north-west Germany. The favourite localities at Glogau are open places among birch and fir woods, where flowers are numerous, on loamy hillocky ground, and where *A. filipendulae* and *A. lonicerae* soon afterwards appear. Its favourite flower is *Dianthus carthusianorum*, on which it sleeps at night, hanging on the calyx as though to be less easily seen. More rarely it frequents *Scabiosa arvensis* (Zeller). Fortification trenches at Stettin, and a plantation on dry sand near the town (Hering); on the chalkhills near Pont-de-l'Arche (Dupont).

Time of appearance.—On June 4th, 1849, Nolcken found, near Riga, about 100 larvæ, which pupated June 6th-20th, and emerged July 8th-23rd. Middle of June at Merlin Park (J. J. Walker), middle of June on Clare coast (Lawless), end of June at Galway, July 1st, 1863, ten days later than usual (Birchall), June 30th, 1880, at Claring Park, worn (J. J. Walker), June 8th, 1887, at Abersoch (Samuels), second week of June, 1889, at Abersoch (Oldham), June 11th, 1893, at Abersoch (Arkle), first fortnight in June, 1896, at Abersoch (Blagg), June 26th, 1858, at Loch Etive (Prof. W. Thomson), July 4th, 1898, nr. Oban (Sheldon), July 10th, 1859, at Ram Heugh, Stonehaven (R. Thomson), June 25th-July 10th, 1844 (Freyer), July 1st, 1897, above Sepey, just emerging (Lowe). It occurs throughout July and early August at the higher elevations in the mountains of Central Europe: July 30th and 31st, 1894, and July 25th-August 3rd, 1898, nr. Bourg St. Maurice and on the Little St. Bernard Pass, August 1st-8th, 1894, at Courmayeur and Mont de la Saxe, August 1st, 1896, at Le Lautaret (at about 8,000 ft.), throughout latter half of July, 1895, at Mendel Pass (Tutt). At Glogau, the best time to obtain good specimens is the first half of July (Zeller). Himsl says: "second half of July to the end of August for East Prussia." Reutti notes it from May until August, in the mountains, up to moderately high elevations in Baden, sometimes more, at other times less, rare. Abundant on July 31st, 1898, on a hill near Pont-de-l'Arche with *A. carniolica* (Dupont).

Localities.—Argyllshire: Taynuilt (Salwey), south side of Oban, in great abundance (Somerville), between Oban and Dunstaffnage Castle, at mouth of Loch Etive (Prof. W. Thomson), Isle of Mull (Somerville *teste* Chapman). Carnarvon: Abersoch (Samuels). Clare: Clare coast (Milner), Burren District, Castle Taylor (More), Black Head (Lawless). Cornwall: Tintagel (*vide*, *Science Gossip*, xvii., pp. 41, 65, 414). Forfar: Ram Heugh, near Stonehaven, by the sea-side (R. Thomson), coast of Forfar (F. B. White). Galway: Ardrahan (More), between Kinvara and Ardrahan (Wright), Claring Park, nr. Kilcornan, and Merlin Park nr. Galway (J. J. Walker), Kilcolgan (Kane); Kilcornan and Oranmore (Birchall), Salthill (Allen).

Distribution.—Africa (north) (Meyrick). Asia: Asia Minor, Hadjin (Manissadjian *teste* Staudinger), Brussa (Zeller), Tokat (Speyer), Armenia, Central Asia, Ala Tau, Lepsa district (Staudinger), Siberia, Obi and Yenesei districts, Pamir, defile of Chakhisnarden (Erschoff), Kokand district (Fedchenko). Austria: Gross Glockner, nr. Pasterze Glacier (Lederer), Patscherkofel, nr. Innsbruck, at 5,000ft., Heiligenblut to 7,000 ft. (Staudinger), Buda (Speyer), Carinthian Alps (Chapman), Mendel Pass district (Tutt), Upper Austria (Himsl), nr. Vienna (Dorfmeister), Bucovina, Krasna, common (Hormuzaki), Cracow (Zebrawski), Brameralp, Styria (Zeller). Denmark: not uncommon (Aurivillius), Seeland (Boie). France: in chalky plains and low mountains only, nr. Paris, Chartres, Besançon, Grenoble, Hautes-

Pyrénées, Champagne, Basses-Alpes (Oberthür), Dept. Eure, Pont-de-l'Arche, Rouen (Dupont), Lardy, Pyr.-Orientales, Dept. Basses-Alpes, Morteau, Vosges, forest of Harth (Berce), Rheims district, Mailly, Épernay, Montfélix (Demaison), Fontainebleau (Lucas), Depts. Meurthe, Maas, Doubs, Digne (Bellier-de-Chavignerie), Pyrénées, nr. Gavarnie at 2,000 mêtres, Savoy (Speyer), Cauterets, Ax, Ariège (Oberthür), Bourg St. Maurice, Petit St. Bernard, Le Lautaret (Tutt), Alpes-Maritimes, Mont Leuze (Bryat), between St. Martin and St. Dalmas, Val du Borréon from 900-1,800 mêtres (Millière), Hautes-Alpes (Guenée), Bois de St. Florent, collines de la Creuse, Guéret, Sologne, Murat (Sand), nr. Hyères (Fallou). Germany: almost everywhere (Kayser), Metz (Selys-Longchamps), Heligoland (Gätke), Stettin (Hering), Mangfall (Gumppenberg), Wittolsheim, Kastenwald, Trois-Épis, Frankenbourg. Lutterbach, banks of Wiese, Dorneck (Peyerimhoff), Silesia (Assmann), Ratisbon (Herrich-Schäffer), Brauenheim, nr. Frankfort-on-Main (Gerning), Prussia, Rastenburg, Marienwerder, Stargard, nr. Dantzig, Holstein, Aachen, Brunswick, Wolfenbüttel, Helmstadt, Baden, Waldeck, Bodethal (Speyer), Augsburg, Glogau (Zeller). Grafenberg (Bohatsch), Saxony (Dadd), Thuringia, Gotha, Erfurt (Knapp), Upper Hartz, Oderbrück, one specimen only (Hoffmann), Brieg, common (Prittwitz). Greece: Crete, Canea (Freyer), Parnassus, Veluchi (Staudinger). Italy: abundant in the north, central and southern provinces (Curò), Sicily (Boisduval), Courmayeur, Mont de la Saxe, Cogne (Tutt), Piedmont, Liguria, Tuscany, Calabria (Speyer). Roumania: Costischa, Grumazesti, Azuga, Kl. Neamtz (Caradja), Comanesti (Leon), Dobrudscha (Mann), Turn Severin (Haberhauer). Russia: Livonia (Staudinger), provinces of Kasan, Orenburg, Saratov (Eversmann), nr. Riga, nr. Koervast in Oesel (Nolcken), Volga provinces, Sarepta, Caucasus, Transcaucasia, Poland to Gulf of Finland, mths. of Danube to Dnieper (Erschoff), Lenkoran (Ménétriès). Scandinavia: southern Sweden, Trolle, Ljungby, Silfåkra, Esperöd, Sandhammer, Småland, etc. (Wallengren). Switzerland: nearly everywhere, but above 6,000 feet scarce (Frey), Oberhaslithal, Grindel Alps, Gemmi (Freyer), Basle (Peyerimhoff), Zermatt (Oberthür), Simplon (Jordis), Grisons, Bergünthal (Zeller), Upper Engadine, above Sils-Maria, Aar and Thurgau, Schaffhausen, Zürich, Glarus, St. Gallen, Berne, Neuchatel, Upper and Lower Valais, Zermatt to the foot of the Stelvio (Frey), Bechburg (Stehlin), Killias, nr. Tarasp (Christ), Gadman (Rätzer), Trafoi (Staudinger), Visp Valley (Jordan). Turkey: Gallipoli (Mathew), ? I. of Crete, Canea (Freyer).

ANTHROCERA (LYCASTES) EXULANS, Hohenwarth.

Synonymy.—Species: *Exulans*, Hoh., "Bot. Reisen," etc., p. 265, pl. vi., fig. 2 (1792); Esp., "Die Schmett.," ii., pt. 2, pl. xli., figs. 1-2, p. 17 (1793); Hb., "Eur. Schmett.," ii., figs. 12 ♂; p. 81, fig. 101 ♀ (? 1803); "Verz.," p. 118 (? 1822); Ochs, "Die Schmett. Eur.," etc., ii., p. 40 (1808); Dalm., "Kongl. Vet. Acad. Handl.," p. 223 (1816); Bdv., "Mon. Zyg.," p. 47, pl. iii., fig. 5 (1829); "Icones," ii., pp. 54-55 pl. liv., 4-5 (1834); Dup., "Lép. France," supp. ii., p. 57, pl. v., figs. 5, *5a*, *b* (1835); Freyer, "Neuere Beiträge," etc., iii., p. 134, pl. 200, fig. 2 (1838); vi., p. 178, pl. 590, fig. 1 (*ante* 1852); Zett., "Ins. Lapp.," p. 919 (1840); H.-Sch., "Sys. Bearb.," ii., p. 37 (1845); Spey., "Geog. Verb. Schmett.," i., p. 344 (1858); Hein., "Schmett. Deutsch.," p. 160 (1859); Staud. and Wocke, "Stett. Ent. Zeit.," xxii., p. 359 (1861); "Cat.," p. 46 (1871); Wallgrn., "Skand. Het.," p. 96 (1863); Lucas, "Hist. Nat.," 2nd Ed., p. 155 (1864); White, "Ent. Mo. Mag.," viii., p. 68

(1871); "Scot. Nat.," i., p. 175 (1872); Knaggs, "Ent. Ann.," 1872, p. 112; Mill., "Cat. Lép. Alp.-Mar.," p. 126 (1872); Curò, "Bull. Ent. Soc. Ital.," vii., p. 196 (1875); Kirby, "Eur. Butts.," etc., p. 89 (1879); "Cat. Lep. Het.," p. 67 (1892); "Handbook," etc., iii., p. 89 (1897); Frey, "Lep. der Schweiz," p. 66 (1880); Schöyen, "Nord. Ark. Lep.," p. 171 (1881); Oberth., "Lép. des Pyr.," p. 30 (1884); Hofmn., "Die Gross-Schmett.," p. 34 (1887); "Die Raupen," etc., p. 36 (1893); Buckler, "Larvæ," etc., ii., p. 13 (1887); Auriv., "Nord. Fjär.," p. 53 (1888); Tugwell, "Y. Nat.," xi., p. 206 (1890); Tutt, "Ent. Record," etc., v., 258 (1894); "Proc. Sth. Lond. Ent. Soc.," 1895, p. 94; "Brit. Moths," p. 354 (1896); Barr., "Lep. Brit.," ii., p. 121 (1894); Meyr., "Handbook," etc., p. 448 (1895). *Vanadis*, Newm., "Entom.," vi., p. 22 (1872). [The synonymy is discussed *Ent. Record*, etc., v., pp. 258 *et seq.*]

ORIGINAL DESCRIPTION.—*Sphinx exulans* (Der verwiesene Demmerungsvogel). *Sphinx*. Alis superioribus hyalino-virescentibus, albido-nervosis, maculis quinque rubris utrinque conspicuis; inferioribus, præter marginem apicis hyalino-virescentem, rubris immaculatis. This moth has the size of *S. statices* or *S. filipendulae*. Head, thorax, abdomen, and the whole body are above and below black, covered thickly with similarly coloured scales. The head small, almost globular, somewhat narrower and stumpily pointed below, and bent downwards. The two palpi are curved upwards, round, black-haired; the tongue lying between them wound spirally, and glittering black-brown in colour. The eyes beneath the antennæ raised, naked and black. The antennæ moderately long, black, not transparent, thread-like, roundish, thickish towards the end, awl-shaped at the point, in front marked with many ring-shaped incisions. The thorax cushion-shaped, with a whitish hairy band, interrupted in the middle. The abdomen longish, almost uniformly thick, stumpy. The six legs whitish or light yellowish. The . . . . fore-wings somewhat oval, of a watery-greenish colour, almost semi-transparent, with four raised whitish ribs, running longitudinally from the base to beyond the middle of the wing, and five red spots apparent both on the upper- and undersides. . . . . The hind-wings have a watery-greenish coloured margin, with a white outer margin, the remainder of the wing being entirely red, unspotted, and almost semi-transparent. This moth inhabits the extreme Alpine summits of the ice-mountains at Glockner, on the so-called Pasterze, and lives probably on the "Eis-" or "ährengetragenden Beifuss" (? *Artemisia glacialis*) which are almost the only plants of this perpetual winter-land (Hohenwarth, *Botanische Reisen nach einigen Oberkärntnerischen benachbarten Alpen*, p. 265). This is evidently only a description of the female.

IMAGO.—Anterior wings thinly scaled, purplish-green, green, blackish-green, or greyish-green in colour, with five red (carmine) spots. Posterior wings carmine, with a narrow grey-green or blackish border.

SEXUAL DIMORPHISM.—The sexual dimorphism of this species is very striking, and has been noticed by almost all entomologists who have studied the species. Dalman described the male without pale collar and pale nervures as *vanadis*, the female as *exulans*. Boisduval notes that the females are veined with white, the corselet and epaulettes whitish, the males bluish-black, with bluish-black thorax, but both sexes with a greyish-white collar. White, apparently misled by certain Continental references, writes (*Entom. Month. Magazine*, viii., p. 68) that "typical *exulans*, from the higher Alps and Pyrenees, have the nervures sprinkled with ochreous, but in the var. *vanadis*, Dalm., which is the Scandinavian form, the wings are more sparingly scaled, and the ochreous is absent." This is hardly correct, as reference to the original type description of *A. exulans* will show, and Dalman (*Kongl. Vet. Acad. Handl.*, 1816, p. 222) distinctly describes *exulans* as being "venis albidis," the Scandinavian form, in this, agreeing with those from all other localities, the ♀ with, the ♂ without, pale nervures, although this pale coloration is certainly reduced to a mimimum in a large number of examples from Bossekop that we have examined. White then goes on to say that, "although the Scotch males have no ochreous, the female has the nervures and collar distinctly marked with that colour." Tugwell notes that "the Scotch females have a yellowish-white collar, and the legs are all yellowish-white, the ridges of the nervures are covered with pale whitish-grey scales, which, when alive and in daylight, make them very distinctive-looking. They have a powdered-looking appearance, as if they had been dusted with flour, ... the fringes are pale whitish-grey." Reid writes that "the Scotch females, when alive and newly emerged, appear as if dusted over with a fine whitish powder; this appearance largely vanishes after death." We have examined some hundreds (or thousands) of this species. Normally the male is smaller than the female, is often bluish- or purplish-green, has the fore-wings more fully scaled, and the dark border of the hind-wings rather broader. It usually has very slight traces of a pale collar (sometimes moderately well-developed), the legs comparatively dark. The female is usually the larger, the fore-wings more distinctly green, the nervures of the fore-wings whitish, whitish-ochreous, or bright yellow-ochreous (sometimes the wings are beautifully dusted with golden scales); the thorax, with a distinct pale collar and pale epaulettes, and the legs paler, sometimes yellowish in tint.

VARIATION.—Within certain narrow limits very variable, each district almost producing a race with some special unimportant characters, that give it a particular facies. These characters, however, are such that almost any particular specimen can be exactly matched by specimens from other districts, if a sufficiently large number be examined. The variation in size of both sexes is remarkable. We have males extending from 19 mm. to 32 mm. and females from 19 mm. to 36 mm. In the Dauphiné Alps, about Le Lautaret, where the insect occurs in countless thousands, the luxuriant pastures about the Hospice produce many exceedingly large specimens; on the mountain slopes, 1,000 ft. above, the specimens become much smaller, and, at last, on the bare herbage on the skrees at the base of the highest peaks, they are quite dwarfed, evidently owing to the larvæ being very badly placed for food. In the ground colour, the scaling shows great differences, some examples being thickly scaled, the green colour bright, and distinctly defined, in others, the scaling is weak, the specimens more than usually inclined to be diaphanous, the colour indefinite, sometimes tending to phæism, at others to albinism, in many cases probably due to insufficient nutrition in the larval stage. The carmine spots also vary in intensity, and often tend slightly to orange (especially when the insect has been on the wing a short time), and Oberthür records (and figures) an extreme aberration with clear yellow spots and yellow hind-wings. The spots tend occasionally to form longitudinal streaks, and then always by the union of 3 + 5 and 2 + 4, as in *A. purpuralis*, but only on one occasion have we met with a specimen with the central area of the fore-wings completely occupied with three large wedge-shaped spots, as is usual in extreme forms of *A. purpuralis (minos)*. Specimens obtained by Dr. Chapman at Bossekop give a small percentage of examples in which spot 5 is somewhat extended outwardly. The hind-wings are sometimes strongly suffused, in none perhaps so strongly as in the most extreme Scotch specimens in this direction, Tugwell noting (*Young Nat.*, xi., p. 206) that, in these, the margin of the hind-wings is often a mere line, at other times it occupies a third of the wing. The principal forms are as follows:—

α. var. (et ab.) *clara*, Tutt, "Ent. Rec.," v., p. 266.—Well scaled, bright green ground-colour, with short, broad wings, somewhat clearly defined dark margin to hind-wings. Females almost as bright and well-scaled as the males, with pale collar, but with no (or ill-defined) whitish markings on thorax, nor whitish nervures. Swiss Alps, Tyrol (Falzarego Pass), Le Lautaret (rare).

β. var. (et ab.) *vanadis*, Dalm., "Kongl. Vet. Acad. Hand.," 1816, p. 222 (♀ form); Staud. and Wocke, "Cat.," p. 46 (1871); Tutt., "Ent. Record," v., p. 266 (1894).—Alis anticis fusco-virescentibus subdiaphanis, maculis quinque rubris, basali exteriori elongata, posticis rubris margine fusco-diaphano latiore; corpore pedibusque nigris pilosis; antennis, brevibus clava crassa. Habitat in Lapponia. Species ut mihi videtur distincta, apud auctores vix invenienda, magnitudine et statura, *Z. exulantis*, sed collare pedibusque nigris, nec venas alarum unquam albido-squamatas in hac specie inveni, nec macularum forma omnino eadem. The corresponding female is described as: *Z. exulans*.—Alis anticis, fusco-virescentibus, subdiaphanis, subtus concoloribus, maculis quinque rubris inæqualibus (venis albidis); posticis rubris margine fusco-virescenti; antennis vix clavatis; pedibus luteis.

Staudinger appears only to describe (*Cat.*, p. 46) the male form, which is noted as "parcissime squamata, albo non mixta," although perhaps he means this to include both sexes, for he notes (*Stett. Ent. Zeit.*, xxii., p. 359) the Scandinavian examples as "having the fore-wings more transparent, of a dull blue-grey tint, rarely with a greenish tinge, whilst the whitish or yellowish atoms, with which the females especially are normally marked, are in these almost lacking, so that the prothorax remains always dark; yet it cannot be called a striking local form." From this it might be assumed that the females were entirely without the paler markings, which is hardly the fact, although, in the specimens from Bossekop, the pale markings are certainly reduced to a minimum. Our own note on this form reads (*Ent. Rec.*, v., p. 266): More sparsely scaled. Dark green ground colour (less brightly tinted than ab. *clara*), males usually without pale collar, mottling on thorax, and pale nervures, and with black or blackish legs; females with sometimes a pale collar, and a little pale mottling on thorax, nervures of fore-wings slightly sprinkled with pale scales, legs pale; the dark margin to hind-wings variable, but rather broad, and sometimes merging indistinctly into the red, females more thinly scaled than males. Inhabits Lapland and Finland, from the Atlantic to the Urals (Reuter and Erschoff), mountains of Italy (Curò), nr. the Bernina glacier, and the Heuthal (Mengelbir). Appears as an aberration with the type and other forms, in Scotland, Cogne Valley, Grauson Valley, Le Lautaret, Andermatt, Little St. Bernard Pass (mts. around the Hospice).

γ. var. (et ab.) *subochracea*, White, "Scot. Nat.," i., p. 174; "Ent. Mo. Mag.," viii., p. 68.—Wings subdiaphanous: front ones dull green with five carmine spots of the same form and arrangement as in the type. Hind-wings dull carmine with all the margins pale dull green. Male—tips of the fringes in all the wings greyish-ochreous. Female—the collar (except in the centre), the legs, and the margins of the red spots more or less ochreous; fringes as in the male, but more ochreous.

This variety differs from the type by the absence of the ochreous tints (except in the female, which is slightly marked with ochreous), and by the broader green margin to the hind-wings of the same breadth in each sex, and from the var. *vanadis*, by the presence of the ochreous tints, and the females, by the more abundant scales on the wings. Inhabits Scotland (Braemar).

This variety was founded on at least three misconceptions. (1) That the normally pale portions of the female wing are more ochreous in the type. (2) That the var. *vanadis* is without the ordinary pale markings of the female. (3) That the var. *vanadis* is a well-scaled form. As to these points—the typical female (*vide*, *ante* p. 444) certainly has the normally pale parts of the wing whitish or whitish-ochreous. The female of the var. *vanadis*, described by Dalman as *exulans* (*vide*, *ante* p. 446) also has the normal pale areas. The var. *vanadis* is described (*vide* p. 446) as being "sub-diaphanous," the very term used by White for *subochracea*. White evidently has mistaken ab. *flavilinea* for the type. Similarly Tugwell has mistaken var. *clara* for the type in his comparison (*Young Nat.*, xi., p. 206 and *Proc. Sth. Lond. Ent. Soc.*, 1894, p. 93) between Swiss and Scotch examples, and the premises being false, the conclusions are necessarily erroneous. We are unable to distinguish clearly between this variety and var. *vanadis*, Dalm., and have numerous specimens from various continental localities that appear to be indistinguishable. A careful comparison of the following notes with Dalman's description of *vanadis* will, we think, make this clear. Reid says that "when alive and newly-emerged, the females appear as if dusted over with a fine white powder," and Tugwell notices the "ridges of the nervures as covered with pale whitish-grey scales," a sexual distinction noticed by Dalman. Tugwell distinguishes (*Ent.*, xxviii., p. 286) the Scotch examples (compared with Oberalp forms, including ab. *clara*, ab. *flavilinea*, etc.): (1) By the less dense scaling and duller coloration. (2) By the more carmine tone of the spots and hind-wings. (3) By the absence of a more or less conspicuous pale collar in the males. (4) By the darker coloration of the legs of the male. He adds that "in the Braemar specimens the red spots are never uniform in colour, but have a deeper tinted centre, surrounded by an ochreous ring." These peculiarities appear to be the essential characters that Dalman gave (*ante*, p. 446) for the Lapland form (*vanadis* ♂ and *exulans* ♀) in 1816, and Tugwell, therefore, not only here, but even more decidedly in the *Young Nat.*, xi., p. 206, confirms our opinion that Scotch specimens answer well to Dalman's description. The only difference we notice in a very long series of Bossekop examples of var. *vanadis* is the rather larger average size of the Scandinavian examples. For the rest, all the essential points noted above as characteristic of Scotch specimens are found here and also in very many Alpine specimens. Whilst, however, this duller form with a minimum of pale markings comprises the bulk of Scotch examples, it includes only a small portion of the Alpine ones. Chapman thinks that the very finest Braemar examples present a *Psyche*-like flimsiness, that is never seen in continental examples. We have examples from Cogne, Le Lautaret, Braemar, etc., that we should refer here.

δ. ♀ *exulans*, Hohen., "Bot. Reis.," etc.—Fore-wings pale greenish, almost semi-transparent, four raised nervures sprinkled with whitish scales, five red spots apparent both on upper and underside; hind-wings red, almost transparent, with pale greenish margin bordered externally with white.

This (the type) is evidently a form closely resembling, even if not identical with, var. *vanadis*, and very different from the well-scaled and brightly-tinted var. *clara*, from some of the Swiss Alps, and often supposed to be the typical form. The specimens from Gross Glockner (whence came the type) in the British Museum, are hardly any brighter than the Scotch form, and the males show, so far as can be judged from half-a-dozen specimens, scarcely any difference from the latter form, except that they exhibit a tendency to develop a well-marked pale collar, a character usually absent in var. *vanadis*, and almost so in var. *subochracea*. From Gross Glockner, Grauson Valley, Andermatt, Le Lautaret, Mont Cenis Pass, Little St. Bernard, Scotland (rare). Reuter, who distinguishes the type from var. *vanadis*, simply by the greater amount of white scaling in the ♀ and a tendency to show a pale collar in the ♂ of the former, notes the type as occurring in Dalecarlia (60° N. lat.) and southern Norway, the var. *vanadis* being confined to the northern regions of Norway, Sweden and Finland, extending to the coast of the Polar Sea.

ε. ab. *flavilinea*, ♀, Tutt, "Ent. Rec.," v., p. 267.—*a*. Well-scaled, very large, the nervures sprinkled with bright orange or golden scales, strongly ochreous collar, thorax mottled with orange scales. *b*. A sub-variety closely resembling the above, slightly smaller, nervures scattered with yellow (not orange) scales, the collar and thoracic mottling pale yellowish.

This is a most beautiful aberration, fairly abundant in many localities. When newly emerged, its wings are covered with the finest yellow or golden scales, and look as if they have just tumbled out of a bag of gold-dust. Grauson Valley, Lauzon Valley, Andermatt, Le Lautaret, etc.

ζ. ab. *striata*, Tutt, "Ent. Rec.," viii., p. 276; "Proc. Ent. Soc. Lond.," 1896, p. xli.—The red spots of the fore-wings more or less confluent and united (2 + 4, 3 + 5), so as to form longitudinal streaks. Andermatt, Le Lautaret, etc.

η. ab. *pulchra*, n. ab.—Alar expanse, 35 mm. Legs yellowish. Thorax covered with ochreous scales; ochreous collar. Abdomen green-black. Anterior wings with bright orange-yellow costal edge, yellow subcostal nervure, dividing into two yellow branches at end of cell (one going towards apex, the other to outer margin above anal angle), and yellow median nervure. These divide the upper and central area of the wing into three sections, in which long red blotches are situated, as in *A. purpuralis*. The first (spot 1) extends along the costa, for three-fourths the length of the wing, the space between the costa and the subcostal nervure, being quite filled up with red for this length. The second (2 + 4) extends parallel to the inner margin of the wing, entirely filling the space between the subcostal and median nervures, leaving only a narrow band of the green ground colour along the inner margin. The third (3 + 5) extends to within 2 mm. of the outer margin. The red, therefore, practically fills the whole of the upper and central area of the wing, leaving only a narrow band of greenish on the outer and inner margins. Fringes greyish, with a dark inner line. Posterior wings entirely red, with dark marginal line, and greyish fringes. The underside of all the wings entirely red, except the outer margin of fore-wings.

The ab. *pulchra* here described is a female specimen of what would have been an individual of the ab. *flavilinea* (the collar, nervures, etc., being of a bright orange tint), had not a remarkable development of the red spots into three blotches, made its markings resemble, in a general way, those of *A. purpuralis*. It is of large size, 35 mm., with the centre of fore-wings entirely crimson, the whole of the spots thus enlarged being united except for the fine yellow lines which run along the subcostal and radial nervures, and thus separate the red area into three patches, somewhat similar to those characteristic of *A. purpuralis*. Le Lautaret (one specimen only).

θ. ab. *flava*, Oberthür, "Variation Lépidop.," p. 43, pl. viii., fig. 141.—The normally red spots of the fore-wings, and the red portion of the hind-wings, yellow in colour (*vide*, Oberthür, *Lép. des Pyrénées*, p. 32). The specimen figured by Oberthür was taken at Le Lautaret, by Martin.

ι. ab. *pallida*, Tutt, "Ent. Rec.," ix., p. 13.—With the wings more or less unpigmented, and pallid in hue; the fore-wings whitish; the ordinary red spots and hind-wings very washed out in appearance, usually pale pinkish or ochreous in tint.

This is a form produced apparently by the failure of the pigment to develop in a normal manner, and is probably the result of want of proper nutrition in the larval state, or to the maturing of the imago under abnormal conditions. Often met with at high elevations in the Dauphiné Alps, Andermatt, etc.

κ. ab. *minor*, n. ab.—Alar expanse 19-21 mm. With the general characters of the typical form, fairly well-developed scaling, and the sexual differences, equally marked in this small aberration. We have at least a dozen examples of each sex, taken on the skrees at the foot of the peaks surrounding Le Lautaret, at an elevation of from 8,000-9,000 ft.

λ. ? var. *exsiliens*, Staud., "Stett. Ent. Zeit.," xlii., p. 393.—The specimen before me has very transparent green-black fore-wings, with five small red spots, which are placed as the five larger ones of typical *exulans*. Of the two basal, the upper is streak-like, very narrow and short, the under somewhat oval, and very small; of the two middle ones, the upper is only like a large dot, whilst the one posteriorly under it appears to be almost heart-shaped, and perhaps as large as the fifth, which is placed at the end of the cell. This latter spot is oval, somewhat sharply defined, and also small. Beneath, the two basal spots are indicated only by single red scales. Fringes very dark, and every trace of whitish or yellow circumscription of the red dots is wanting. The hind-wings very broadly margined, extending almost to the centre, and blackish at the base, the black preponderating, and limiting the dull red to the middle and towards the inner angle. Head and body entirely black; the legs, in part, somewhat yellowish-haired. Whether this form is really distinct from *A. exulans* can only be made certain by the capture of a larger number of examples. A single ♂, which Haberhauer stated that he captured on the bare Tarbagatai mountains, in Central Asia.

This appears to have been the sole record for *A. exulans* in Asia until the last summer (1898), when, in July, Elwes captured specimens in the Altai mts. that do not seem very unlike some European examples.

Ovum.—Large, oval in outline, inclined to be broader at one end than the other; pale yellow in colour, but of a rather deeper tint at the broader end. There is no noticeable depression on the upper surface, and the shell appears to be almost smooth, somewhat wrinkled longitudinally, and shiny. Under a two-thirds lens, used as a hand-glass, neither of the poles appeared to be transparent. [Described August 7th, 1898, from egg laid by ♀ captured on the Petit St. Bernard.] Buckler notes the egg as being of large size for that of the insect, of long, cylindrical, round-ended shape, having a depression bending inwards, rather irregularly on one side; the shell very thin and very slightly reticulated all over, in colour ochreous-yellow, changing to orange-ochreous, and finally to dark greenish-slate colour, very shining from the first to the last.

Habits of larva.—The larvæ hatch in about three weeks from the time that the eggs are laid, and they feed well on *Lotus corniculatus* in confinement, although they are rather general feeders in their alpine homes. The first moult takes place in about three weeks from the time of hatching, but in early September, and when still very small, they fix themselves for hybernation, and do not feed again until well on into the spring. Buckler's observations suggest that the larvæ may at least take sometimes two years to attain their full growth, for two small specimens, which he received in the middle of

July, 1882, from Zermatt, with other full-fed examples, fed but little, and in August laid up for hybernation, one going safely through until April 19th, 1883, when it commenced feeding again. Baker reports them as having a great fondness for water, but Buckler sprinkled the food of some in his possession with disastrous results. They feed in a state of nature in the sunshine, almost buried in the tufts of the leaves of *Silene acaulis* or in the fleshy mass of *Cherleria sedoides*, as well as on many other Alpine plants. Bateson says that in climbing the Tosa Falls Valley (July 9th-16th, 1897) he noticed that he first passed the imagines, freshly emerging; then he came across the cocoons, either on stones or on twigs of the Alpine rhododendron, then he found smaller larvæ higher up, and at last he dug out several that were still buried in the snow.

Larva.—When *newly-hatched* the larva is "a plump sausage-shaped little creature" (Buckler), with a black, shiny head, yellowish-olive-green in colour, most minutely dotted with black, and having a row of subdorsal orange blotches. The usual tubercles are black, each bearing a long, pointed black bristle. The skin is rather pubescent. After its *first moult*, the larva appears much paler coloured, of a drab tint, and showing dark subdorsal markings, but when it is about three weeks old the larva is dark olive-green on the back, with the sides lighter green, and it has a subdorsal row of dark brown tubercular warts, with a faint stripe of yellowish below them. It is about two lines in length *just before hybernation*, the colour dark olive-green with an interrupted black subdorsal stripe, below which at the end of each segment is a transverse oval spot of orange-yellow, the surface of the skin being much covered with little fascicles of black hairs. *After hybernation*, it moults again, and is then about 3½ lines in length, its colour on the dorsum and sides dark green, and so much covered with black bristly hairs radiating from the warts, as to appear blackish-green in comparison with the olive-greenish-yellow tint of the ventral area. The dorsal marking is velvety-black. The larva reaches the *blackest stage* towards the end of June and beginning of July. It is then "intensely and beautifully black, which gives additional brilliancy by force of contrast to the light greenish-yellow lateral spots." The head is black and shining, the prothorax green and smooth in front; the segmental divisions, when the larva is stretched out, appear greenish, but all the rest of the upper surface is thickly covered with black hairs. Buckler describes the *full-grown larva* as being from seven to eight lines in length, sometimes more, and nearly three in breadth, of elliptical figure, but with the head small and retractile within the 2nd segment (prothorax), and this also being in part retractile, is twice as long as any of the others, and tapering in front; the anal segment is slightly tapered and rounded off behind; all the segments are plump, and cut extremely deep; the head is black and glossy, with green upper lip edged with black, the antennal papillæ whitish tipped with black; the front, retractile, half of the second (prothoracic) segment is green and naked, the other half and likewise all the other segments of the body have the ground colour of the back and sides very dark green; along each side is a broken velvety-black stripe interrupted at the end of each segment beyond the second (prothoracic) or third (mesothoracic) segment by a bright yellow elliptical transverse spot; each segment bears a series of ovate tubercular eminences, thickly studded with short black radiating bristles, and a single long and fine hair. These almost or quite hide the green ground of the upper surface of the skin. The spiracles are black, the smooth naked belly is of a green, rather less dark than that of the back; the anterior legs are black and shining, with light green joints on the outer side, and light green inner surface; the ventral and anal prolegs are of a lighter green than that of the venter and semitransparent.

Cocoon.—The cocoons are spun on stones, stems of juniper, and, in fact, anything that occurs in their Alpine localities. They are sometimes so abundant that we have seen as many as five cocoons partly covering one another on one short piece of *Vaccinium*. They vary much in size, but are usually about twice as long as wide; they are bluntly fusiform, swelling considerably at the centre and rounded somewhat at each end. They are of a light greyish-yellow or pearly-grey colour, somewhat smooth and lustrous, and so thin and delicate, that after the pupa has left the cocoon, the latter is semi-transparent. We have found them on *Empetrum*, *Vaccinium*, juniper and grasses, also on the bare face of a rock. They are usually, however, placed near the ground.

Pupa.—The pupa usually only projects itself partly out of the cocoon, although occasionally it emerges entirely before the moth is disclosed. It varies in size, some of the male pupæ being very small, some of the female pupæ very large. It is very delicate and easily injured, and somewhat stumpier than is usual among its congeners. Buckler says that it is "of the usual Anthrocerid form, with long antenna- and leg-cases, free nearly their whole length; the short wing-covers, with nervures in strong relief, have their margins prominent from the body. The abdomen tapers just towards the rounded-off tip, and across the back of each segment anteriorly is a narrow ridge thickly set with most minute hooks pointed backwards. The colour is blackish-green on the abdomen, and all the other parts black and with rather a dull surface."

Food-plants.—*Silene acaulis*, *Cherleria sedoides*, *Trifolium alpinum*, *T. repens*, *T. pratense*, *Geum montanum*, *Sibbaldia* (*Azalea*) *procumbens* (flowers preferred, Frey), *Alchemilla alpina*, *Medicago lupulinus*, *Rumex acetosa*, *Lotus corniculatus* (Buckler), *Erica*, *Vaccinium*, *Polygonum aviculare* (White), *Empetrum* (Staudinger).

Habits and habitat.—A sluggish species, flying only in the sunshine, and then booming along bee-like from flower to flower, and at last settling on a flower motionless for a considerable time; in dull weather hiding low down among the roots of the herbage in its home, and practically undiscoverable at this time. This Alpine and Arctic species was added to the British list by Traill and Buchanan-White, who, on July 17th, 1871, first captured specimens in the neighbourhood of Braemar, at an elevation of from 2,400 ft. to 2,600 ft. White states that the locality is an ancient shore of a glacial sea. The insects occurred in a grassy and rushy spot, sitting on flowers of *Gnaphalium dioicum*. Tugwell records it from ground in the same district, which is not grassy, but covered with crisp heath and dwarf *Azalea* a few inches high, and grey with lichens. Maddison notes that he has found it on rough banks, at high elevations in the deer forest at Braemar. Horne says that, in this locality, it frequents what are called the "flats," *i.e.*, the tops of a range of hills extending for several miles, at an altitude of 2,000 ft. to 3,000 ft. They always prefer the parts that are stony, and are rarely seen where the heather grows freely. They are very sluggish in their habits. Reid says that the insect is very rare on the mountain slopes where plant-life is luxuriant, being almost confined to the lichen-covered wind-swept flats on the mountain tops, and that, in its head-quarters, the food-plant grows in small, dwarf, straggling patches among the stones and rocks. As we go north the altitude at which it is found decreases, and Staudinger and Wocke record that, at Bodö, on May 19th, 1860, the full-grown larvæ were found on the marshes, which were only a few feet above the level of the sea, and later at Alten, where it occurred not only on the marshes, but also in quite dry pine-woods, and later on the high mountains. As we go south, on the other hand, the altitude at which it is found gradually increases, until in the central Alps it is rarely found below 6,000 ft., and often reaches above 8,000 ft., or as high as its food-plants can find sustenance. We have ourselves rarely found it below 6,500 ft., whilst it appears to be more abundant at 7,000 ft. Frequently at these levels it is to be observed in the utmost profusion. At Le Lautaret, in August, 1896, we saw it in countless numbers, booming everywhere on all the mountain slopes around. In dull weather the moths hide at the roots of the plants that clothe the mountain sides, but the slightest gleam of sunshine is sufficient to stir them into the greatest activity. It appears to be fairly widely distributed in the Braemar district, and probably has a greater range in the northern Highlands than has yet been discovered. Hohenwarth captured the type specimens of this species on the extreme Alpine summits of the Gross Glockner, on the so-called Pasterze, and surmised that it lived there on the "Eis-" or "ährengetragenden Beifuss" (*Artemisia glacialis?*), which are almost the only plants of this perpetual winter land.

Time of appearance.—Larvæ found July 2nd, 1851, in the Oberhaslisthal, pupated July 5th-8th, emerged after 20 days from July 25th-28th (Freyer); often observed between July 26th-August 7th, at Bossekop and Skaadavaara (Zetterstedt), first imago on June 26th, 1860, at Bodö (Staudinger), imagines abundant at Bossekop, from July 9th to 20th, 1898 (Chapman), July 25th to August on the highest summits of the Dovrefjeld mountains (Boheman), August 9th, 1851, on the Gemmi (Freyer), end of June, 1817, on the summit of the Lozère (Duponchel), July 15th, 1897, on the Gemmi, just appearing (Lowe), July 9th-16th, 1897, in Tosa Falls Valley (Bateson), July 17th, 1871, at 2,400-2,600 ft. (White), July 17th-25th, 1871, at Braemar (Traill), July 10th-17th, 1886, at Braemar (Tugwell), at the end of June and during the first half of July at Braemar (Horne). In early seasons it may be out in Scotland before the end of June. In Central Europe in the Alps, at about 6,500 feet, it appears in the middle of July, but keeps coming out at successively higher levels until the middle of August. Chapman found it abundantly on August 20th, 1894, in the Grauson Valley (high above Cogne) in Piedmont, and still later in 1895, at Oberalp (Switzerland). We found it well out on the Mont Cenis Pass, August 1st-5th, 1897, and on the Petit St. Bernard, August 3rd-5th, 1898, at Le Lautaret and the Col du Galibier, August 1st-8th, 1896, very abundant, August 10th-15th, 1895, on the Falzarego Pass (above Cortina), August 8th-20th, 1894, in the Cogne, Lauson and Grauson Valleys (Tutt). Elwes found this species on the pass between Kurai in the upper Tchuja valley, and a tributary of the Bashkaus river, above the tree limit, at a height of 7,000 feet, on July 25th, 1898.

LOCALITIES.—ABERDEENSHIRE: Braemar, the hill-tops, at an elevation of from 2.000-3,000ft. (White, etc.). ? ARGYLESHIRE: mountains in Glencoe district [on July 8th, 1898, flying in sun at 3 p.m., about 1,000 ft. above sea-level, a single very worn specimen of this species, or one not hitherto recorded as British (Sheldon)].

DISTRIBUTION.—Asia (central): Tarbagatai mts. (Haberhauer), Altai mts. (Elwes). Austria: Glockner (Hohenwarth), Austrian Tyrol—Falzarego Pass, most of the high mts. around Cortina (Tutt), Styrian Alps (Boisduval), Carinthian Alps (Hübner), Salzburg, Heiligenblut (Staudinger), Oetzthal, Riffelsee, Breitlehnerjoch, very common (Escherich), Paschterkofel, nr. Innsbruck, at 6,000 ft., Sth. Tyrol, at 7,000 ft. (Speyer), Bohemia—Burglitz (Heinemann). France: Savoy Alps (Lucas), Mont Cenis Pass, Dauphiné Alps—Le Lautaret, La Grave, Col du Galibier, etc. (Tutt), Pyrenees—Vallée d'Eyna, sommet du Nethou, le Monné, au-dessus de Cauterets (Oberthür), Hautes-Pyrénées (Boisduval), Dept. of Doubs, Mont d'Or, at 1,360 mêtres (Bruand), nr. Allos (Donzel), Faille-feu. 2.000 m. (Bellier), Lozére (Duponchel), Plateau du Cantal (Sand), Basses-Alpes, Larche, Barcelonnette (Berce). Italy: Cogne, Val Grauson, Val Lauzon, Petit St. Bernard, etc. (Tutt), Alps of Valtellina (Curò), Great St. Bernard (Jordan). Russia: Finland (Reuter). Tundra dist. from White Sea to Ural (Erschoff). Scandinavia: everywhere abundant in the mountains (Aurivillius), Norwegian Lapland, Finmark, Gamstenstind, Lyngen, Bossekop, Skaadavaara (Zetterstedt), between Lake Kilpisjaur and Tromsö (Frigelius), on the highest summits of the Dovre mts., Drivstuen, Kongswald, Fogstuen, Tofte, Jettefjellet, etc. (Boheman), Muonioniska (Kolström), Tornean Lapland (Dalman), more typical forms in Dalecarlia (about 61° N. lat.) and in the mountains of southern Norway, the var. *vanadis*, in the mountains of northern Sweden and Norway to the coasts of the Polar Sea (Reuter), Dovrefjeld and Arctic Norway, Saltdalen (Sahlberg), Porsanger, Elvenaes (Sandberg), Hammerfest, Rolfsö, North Cape (Schneider), "Sandholm" Fjords (Schöyen), Bodo, Alten, (Staudinger), Domaas, Jerkin in the Dovrefjeld, Snaehatten (one in snow) (Champion). Switzerland: from the western boundary of Valais to beyond the eastern boundary of the Grisons, from 5,000 ft.-8,000 ft., the Stelvio, most abundant (Frey), Oberalp, Andermatt (Chapman), Schwarze See, nr. Zermatt (Buckler), Tosa Falls Valley (Bateson), Glarus, Kandersteg, Schwarenbach, 6,200 ft.-6,400 ft. (Speyer), Oberhaslisthal, 8,000ft., Grindel Alps, the Gemmi (Freyer), Heuthal and nr. the Bernina glacier (Mengelbir), on the Tschita, Ober-Albula nr. Hospice (Zeller), Mattmark See (Jones), Val de Fain, 7,000 ft. (Stainton).

ANTHROCERA (THERMOPHILA) VICIÆ, Schrank.

SYNONYMY.—Species: *Viciae*, Schrank, "Fuessly's Neues Mag.," ii., p. 208 (1785); "Fn. Boica," ii., p. 238 (1801); Bork., "Rhein. Mag.," i., p. 638 (1793); Ill., "Mag.," ii., p. 40 (1802); Hb., "Eur. Schmett.," text, p. 80 (? 1805); "Verz.," p. 117 (? 1822); Werneburg, "Beiträge," etc., i., p. 501 (1864); Kirby, "Cat. Lep. Het.," p. 67 (1892); "Handbook," etc, p. 93 (1897); *nec* ? Bork., "Sys. Besch.," ii., p. 162 (1789); *nec* Hb., "Eur. Schmett.," fig. 11 (? 1805). *Melilothi*, Esp., "Die Schmett.," ii., pt. 2, p. 10, pl. xxxix., figs. 1-8 (1789). *Meliloti*, Ochs., "Die Schmett. Eur.," ii., p. 43 (1808); Bdv., "Mon. des Zyg.,"

p. 51, pl. iii., fig. 5 (1829); "Icones," p. 56, ? pl. liv., fig. 6 (1834); Dup., "Hist. Nat.," supp. ii., p. 62, pl. v., fig. 7 (1835); Evers., "Fauna Lep. Volg.-Ural.," p. 96 (1844); H.-Sch., "Sys. Bearb.," ii., p. 35 (1845); Assmn., "Besch. Schmett. Schles.," ii., p. 9 (1845); Kayser, "Deutsch. Schmett.," p. 168 (1852-9); Speyer, "Geog. Verb. Schmett.," i., p. 345 (1858); Hein., "Schmett. Deutsch.," p. 161 (1859); Wallgrn., "Skand. Het.-Fjär.," p 97 (1863); Nolck., "Lep. Fn. Estl.," i., p. 99 (1868); Staud., "Cat.," p. 46 (1871); Tugwell, "Entom.," vi., p. 184; Lewis, Ibid., p. 238 (1872); Barr., "Ent. Mo. Mag.," ix., p. 111 (1872); Knaggs, "Ent. Ann.," p. 40 (1873); Briggs, "Ent. Mo. Mag.," x., p. 116 (1873); "Proc. Ent. Soc. Lond.," pp. xiv-xv (1875); Curò, "Bull. Soc. Ent. Ital.," vii., p. 196 (1875); Sand, "Cat. Lép. Auv.," p. 22 (1879); Frey, "Lep. der Schweiz," p. 67 (1880); Peyer., "Cat. Lép. Als.," p. 47 (1880); Kirby, "Eur. Butts.," etc., p. 90, pl. xxi., fig. 9 (1880); Oberth., "Lép. des Pyr.," p. 32 (1884); Hofmn., "Die Gross-Schmett.," p. 34, in part (1887); "Die Raupen," etc., p. 36 (1893); Gregs., "Young Nat.," viii., p. 229 (1887); Tugwell, Ibid., ix., pp. 53, 99, 131, 174 (1888); Briggs, Ibid., ix., pp. 82, 108, 153, 188 (1888); Auriv., "Nord. Fjär.," p. 53 (1888); Reuter, "Macr.-Lep. Fin.," p. 20 (1893); Barr., "Lep. Brit. Isl.," ii., p. 24, pl. lix., figs. 1 *a-c* (1894); Meyr., "Handbook," etc., p. 448 (1895); Tutt, "Brit. Moths," p. 355 (1896); Reutti, "Lep. Bad.," 2nd Ed., p. 44 (1898). *nec Meliloti*, Hb., "Eur. Schmett.," fig. 58 (? 1805); *nec* Wood, "Index Entom.," p. 11 (1839). *Lonicerae* var., Esp., "Die Schmett.," ii., pt. 1, p. 195, pl. xxv., fig. 3 (1781). *Loti*, ? Schiff. and Denis, "Sys. Verz.," p. 45 (Cat. name) *teste* Ochsenheimer (1776); Hb., "Eur. Schmett.," ii., fig. 82 (1803), corrected to *viciae*, Ibid., text, p. 89 (? 1805). *Buglossi*, Dup., "Lép. France," supp. ii., p. 138 (1835). *Ytenensis*, Briggs, "Young Nat.," ix., p. 82 (1888).

ORIGINAL DESCRIPTION.—*S. viciae.* Grünlichtschwarz; die Vorderflügel mit fünf rothen Flecken; die Hinterflügel roth, schwarz gesäumt. Nigrovirescens; alis anticis maculis rubris quinque; posticis rubris, nigromarginatis. Um die Hälfte kleiner als die vorige Art [*A. filipendulae* (including *A. lonicerae*)] [Schrank, *Fuessly's Neues Mag.*, ii., p. 208 (1785)]. [In bringing forward *viciae*, Schrank, as the correct name for this species, modern authors have undoubtedly been guided by the fact that it was recognised by all their early predecessors — Borkhausen, Hübner, Illiger, Ochsenheimer, Boisduval, etc., as applying to the same species that Esper described under the name *melilothi*. In those days, however, the law of priority had no existence, and each author chose any he pleased of existent names, or, as in the case of Retzius, named the species anew. We have followed Kirby, largely, however, on the evidence of Illiger, who says in his edition of the Vienna Catalogue [*Sys. Verz.*, pp. 36-37 (1801)]: "Schrank's description of *viciae* (made from the insect in the Vienna collection) is very incomplete. As a supplement to this diagnosis the species may be further described as half the size of *lonicerae*, similar in markings and colour, but the ground colour of the fore-wings not so distinctly steel-blue, and the red less bright, more carmine; the wings not so pointed, the apex more bluntly rounded, two basal spots similar, but the central pair notably different, 3 being round in *lonicerae*, and divided from 4 by a nervure, whilst 3 forms a long oval or thick comma in *viciae* (the rounded part pointing to apex), and separated more widely from 4; spot 5 has a different direction, lying obliquely to 4 and nearer apex. The antennæ in *viciae* are blunter," etc.]

IMAGO.—Anterior wings 22-32 mm., dull greenish in colour, thinly scaled, five small reddish or carmine spots. Posterior wings red, dark marginal border very narrow. [One of the best detailed descriptions made from continental examples of our British species is that by Boisduval, *Mon. des Zyg.*, pp. 51-52.]

Sexual dimorphism.—The similarity of the sexes of this species is remarkable. On the whole, the females are larger than the males, and rather less thinly scaled, whilst Boisduval observes that the females occasionally have the ground colour greyish-green. The largest female in our collection is 32 mm., the largest male 29 mm. The former vary from 26 to 32 mm., the latter from 22 to 29 mm. On the whole, the dark hind marginal border of the hind-wings is broader in the males than in the females, especially in the eastern races of the insect.

Comparison of A. viciæ with A. trifolii (-minor).—Some British lepidopterists have suggested that our native *A. viciae* (*meliloti*) is not identical with the species known by the same name on the Continent. The specimens in the British Museum and our own collection show that the insect we get exists unchanged in France, Germany, Switzerland, Austria and Russia. (The mixing up of the densely-scaled, six-spotted, southern *A. charon*, Hb., with this species by some continental authorities does not affect the question.) Nolcken notices (*Lep. Fn. Estland*, p. 99) a pair taken *in cop.*, among the typical form, as having a "broad margin" to the hind-wings. Briggs reports (*Proc. Ent. Soc. Lond.*, 1875, pp. xiv-xv), breeding *A. trifolii* (*-minor*) from eggs laid by *A. viciae*, but here some error of observation appears to have occurred, Fletcher having since confirmed the fact that they not only breed true and are quite distinct in all their stages, but that the larva of our species agrees with Esper's description of the larva of his *A. meliloti*. Bateson and Pierce find the male genital organs quite distinct. A comparison of the imagines shows that *A. viciae* is a more slender and less densely clothed species, with narrower wings, semidiaphanous, even when fine, the green ground colour duller, the red more carmine, never showing the solid scaling and brighter coloration, the marginal border of the hind-wings very much narrower, and the antennæ more slender than in *A. trifolii*. Tugwell says that the antennæ of male *A. viciae* (*meliloti*) are one-fifth shorter than those of the smallest *A. trifolii* he had, the thickening of the club less sharp, and the end or tip more blunt.

Variation.—There is little marked variation in the British and Central European examples of this species. Some difference in size is observable, and the width of the marginal border of the hind-wings varies in both sexes. Considerable difference, too, occurs in the size of the lower of the central pair of spots. Fletcher has bred an example (from the New Forest) with traces of a sixth spot; Bright has one, and Christy four, examples from the same locality, with traces of this spot below the apical one, and three others with a very slight redness of that part of the wing where this occurs. Two similar specimens are in the British Museum collection, in which the sixth spot is distinctly developed; these came from Stettin (Hering coll.). Esper's pl. xxxix., fig. 1, shows a sixth spot on the underside, and Briggs states (*Young Nat.*, ix., p. 189) that this peculiarity is sometimes noticeable in British specimens; Bright notices it in two examples, whilst Christy notes a suffused redness on the underside in the position which a sixth spot (if present) would occupy. This form showing the sixth spot we would call ab. *sexpunctata*, n. ab. Aberrations also occur in which the spots are more or less confluent. This confluence usually takes place between 3 and 5. Such forms have occurred occasionally near

Stettin and in other localities, whilst Rye records a specimen from the New Forest, with the red spots united as in *A. purpuralis*, and separated only by the nervures. This mode of blotching, so rare in Europe, becomes, according to Staudinger, common in the Ala Tau district, and forms the bulk of the var. *confusa*, Staud., so that we have here another illustration of a rare aberration in one locality becoming the common form in another. Boisduval notes (*Mon. des Zyg.*, p. 52) that it occasionally happens that the spots are united into an irregular band, and King and Fletcher record specimens from the New Forest that have the red spots of the fore-wings all united into a single long red blotch. This extreme red form might be called ab. *confluens*, n. ab. Staudinger refers to *stentzii*, Frr., as an aberration of this species with a red abdominal belt, and records it from the southern Alpine valleys and Armenia. It is remarkable that in most localities where typical *A. viciae* occur, this aberration is very rarely noticed, although Christy has two New Forest specimens with slight traces of a red abdominal belt. Hering notes it as unknown in North Germany, and Nolcken as unknown in the Baltic provinces of Russia. Caradja says it occurs, however, with the type and ab. *dahurica*, in Roumania. *A. charon*, Hb., considered by Calberla and others to be a transalpine six-spotted form of *A. viciae*, is, in our opinion, most decidedly a perfectly distinct species, the evidence offered by Christ and Calberla being quite insufficient to confirm their opinion with any degree of certainty. Bright notes that he has a specimen from the New Forest with the left hind-wing orange instead of red.

α. ab. *stentzii*, Freyer, "Neuere Beiträge," iii., p. 120, pl. 278, fig. 4 (1839). ? *Meliloti* var., H.-Sch., "Sys. Bearb.," ii., figs. 86-87 (1845). *Cingulata*, Frey, "Mitt. Sch. Ent. Ges.," vii., p. 14 (1887).—Konewka has four specimens of an insect in his collection, which he calls *stentzii*, but does not know whether they are a distinct species or an aberration of some other. Of this *stentzii*, I give a figure for comparison. The difference between it and *Z. dorycnii*, Ochs., is so striking, both in colour and markings, that those who have considered them identical cannot have known the true *dorycnii* in nature (Freyer).

Staudinger refers (*Cat.*, p. 46) this figure of Freyer's to *A. meliloti*, with the note: "Abdom. rubro-cingulato." In our own judgment, Freyer's figure scarcely represents a form of *A. viciae*. It appears to us something like a small *A. trifolii*, thickly scaled, with five distinct red spots, ground colour deep green, broad border to the hind-wings; a red ring round the abdomen just above the terminal segments; the underside paler, and spots distinct. (The *dorycnii* referred to by Freyer is a six-spotted species with distinct spots, deep green ground colour, and broad hind margin to posterior wings.) Neither do Herrich-Schäffer's figures, 86-87, appear to represent our insect, although referred here by Staudinger and others. On the other hand, Speyer says the five-spotted form with red girdle is found near Rhoden and Wildungen, with the type; he also states that it occurs occasionally as an aberration in North Germany. Hering, however, distinctly states that it does not occur in Pomerania, but adds that it differs in no way from *A. meliloti*, except in the possession of a red abdominal belt, and further, that Stentz himself assured him that in his locality the insect occurred partly with and partly without the belt, and that it could only be looked upon as an aberration of *A. meliloti*. As Hering probably saw specimens of *stentzii*, his judgment is valuable, since he knew more, perhaps, than any other German lepidopterist of his time about *A. viciae* (*meliloti*). We are the more inclined to consider this as really an aberration of the true *A. viciae*, as there is one of Lederer's specimens labelled *stentzii*, in the British Museum, from Achalzek in Transcaucasia (and we observe that Erschoff records it from this district), which is an undoubted red-belted *A. viciae*, and Christy also has, as we have already noticed, two New Forest specimens showing this peculiarity in a slight degree. Frey notes this form from Bergell (Pfaffenzeller), Macugnaga, at 4,039 ft. (Staudinger), and once near Zürich (Snell). Caradja remarks that of 300 examples captured in Roumania, 15 are typical, six are ab. *stentzii*, Freyer, the rest ab. *dahurica*, Bdv., and ab. *dacica*, Car. (*annulata*, Car.). Knapp notes it from Thuringia—Gotha, etc.

β. var. (et ab.) *dahurica*, Bdv., "Icones," ii., p. 57, pl. liv., fig. 7 (1834), nec *dahurica*, Mill.—Alis anticis subelongatis, apice subrotundatis, cyaneis vel virescenti-subcinerascentibus, maculis quinque rubris; posticis rubris margine cyaneo.

Boisduval remarked that this was near *A. meliloti*, and possibly only a local form of it, but that in this genus the species are often so near, that when the larvæ are unknown it is very difficult to decide whether certain individuals form a variety or distinct species. He noted it as "a quarter larger than *A. meliloti*, its fore-wings distinctly more rounded at the apex, with the five spots placed almost, identically the ground colour less transparent, the fringes blue-black; the hind-wings red (slightly rosy), the border blackish, broader than in *A. meliloti*; the corselet and abdomen blue-black; the antennæ blackish, rather more blunt than in *A. meliloti*. From Daourie, in south-eastern Siberia." The figure certainly might represent a local form of *A. viciae* (*meliloti*). Staudinger diagnoses (*Cat.*, p. 46) it as "al. post. margine latiore nigro. South-east Siberia." Calberla has seen examples from eastern Asia, which undoubtedly represent a var. of *A. meliloti*, but these he avers differed in the antennæ from Boisduval's description. Caradja records a form corresponding with the broader-margined *dahurica*, from Roumania, which is fully described under his ab. *dacica* = *annulata* (*vide*, *infra*). Erschoff records it from the North Amurland districts.

γ. ab. *dacica*, Caradja, "Iris," 1893, pt. iv., p. 192. *Annulata*, Carad., "Iris," viii., p. 72 (1895).—The specimens of *A. meliloti*, captured in Roumania, are chiefly ab. *dahurica*, and a transition form, in which the hind-wings have a very wide black border, leaving only a small central space red in many examples. As a rare aberration, I have captured some forms of *dahurica* that have a red abdominal belt, and this form I name *dacica*. This ab. stands in the same relation to var. *dahurica* as ab. *stentzii* does to the type form.

Later, Caradja renamed this form *annulata*, and said: "From ordinary *meliloti* . . . . our Roumanian form differs constantly in its smaller size (22-23 mm.), its narrower and more pointed wings, the smaller round red spots, and somewhat thinner antennal shaft. It forms, therefore, in many ways, a well-characterised local race, which I consider to agree with the true var. *dahurica*, Bdv., since it agrees with the figures that Boisduval (*Icones*, pl. liv., fig. 7) and Duponchel (*Hist. Nat.*, supp. ii., pl. xli, fig. 2) give of the form, and I have seen almost identical specimens from Central Asia, after which, indeed, Boisduval erected his var. *dahurica*."

δ. ab. (*aut* var.) *buglossi*, Dup., "Lép. France," supp. ii., p. 138 (1835).—This *Zygaena* was sent to Feisthamel by M. Escher, of Zürich, under the name of *buglossi*. Boisduval, who received it from the same person, says, in the *Icones*, that it does not differ from *meliloti*. We consider that it approaches nearer to *dahurica*, from which it is in fact only to be distinguished by the more slender antennæ, and the more rounded apex of the fore-wings.

ε. var. *ehnbergii*, Reuter, "Förteckning öfver Macrolepidoptera," p. 22 (1893).—Minor alis anticis maculis minoribus, posticis margine late nigris, ♂. Denna mykket egendomliga form har tillsändts prof. Aurivillius till påseende och af honom ansetts vara en säregen varietet af *meliloti*. Den synes närma sig den i sydöstra Sibirien anträffade var. *dahurica*, Bdv., men torde dock näppeligen vara identisk med densamma. Varieteten är uppkallad efter dess upptäckare, kand. K. J. Ehnberg. —Kuhmois: Pasi gästgifveri (Ehbg.) i ett enda honexemplar den 21 juli, 1882, tillsammans med hufvudformen.

Reuter notes (*Acta Soc. F. F. F.*, ix., p. 20) that previous to 1893, *A. meliloti* had been confused with *A. trifolii*, both species having stood in northern collections under the latter name. Aurivillius states that the subcostal nervure of the hind-wing in *A. meliloti* is "a short central piece, united with the first median nervure," but this character appears to be very variable. Specimens sent by Reuter to Aurivillius were returned by the latter with the remark that German and south European *A. trifolii* were much larger than Finnish examples, and more like *A. lonicerae*, and that *A. meliloti* was difficult to separate from the small *A. trifolii*. Reuter, after further investigation, came to the conclusion that both species occurred in Finland, *A. meliloti* being, however, much more local than *A. trifolii*. The occurrence of the true *A. meliloti* in Finland was first discovered by Ehnberg. It has been taken at Fagervik, July 11th, 1890, Kuhmois, July 21st, 1882.

ζ. var. *confusa*, Staud., "Stett. Ent. Zeit.," xlii., p. 398 (1881).—Haberhauer sent me in two years about 200 specimens of this species, doubtless all from the Ala Tau. A small number of the specimens were typical *A. meliloti*, with 5 isolated red spots, but, in the greater part, the spots are confluent, often only the two outer and upper (3 and 5), often only the two lower (2 and 4), and specimens are by no means rare in which the spots are as confluent as those of *A. purpuralis* (*pilosellae*) or *A. brizae*. Since the specimens with confluent spots formed by far the great number . . . . . the race may be designated as var. *confusa*. . . . . . In occasional examples the fore-wings are almost entirely red, with dark margins. . . . . . Lederer received one similar to these last from the Altai, and we received no female with 5 isolated red spots from the Ala Tau.

η. (?) var. *charon*, Hb., "Eur. Schmett.," ii., fig. 21 (1797); H.-Sch., "Sys. Bearb.," ii., figs. 69-70 (1845). *Italica*, Caradja, "Iris," viii., p. 71 (1895). *Teriolensis*, Speyer, "Geog. Verb. Schmett.," i., p. 462 (1858).

(1) ab. *decora*, Led., "Verh. zool.-bot. Ver. Wien," ii., p. 125 (1852). *Stentzii*, H.-Sch., "Sys. Bear.," ii., fig. 23 (1845). *Cingulata*, Frey, "Mitt. Sch. Ent. Ges.," vii., p. 14 (1887).

(2) var. *sicula*, Calberla, "Iris," viii., p. 216 (1895). *Scabiosae* var., Rag., "Nat. Sic.," vi., p. 237 (1887).

A. charon, Hb., "Eur. Schmett.," p. 81.—Breiträndiger Schwärmer. Sph., fig. 21. Mas. Fore-wings bright, glossy blue-black, with six very unequal carmine-red spots, the hind-wings steel-blue, only from the base outwards carmine. Piedmontese Alps.

Christ first associated [*Mitt. Sch. Ent. Ges.*, vi., p. 40 (1880)] *A. charon* with *A. viciae (meliloti)*. He noted that in size *A. charon* averaged from 1-2 mm. less in wing expanse, was of brighter colour (red and green), had sometimes a well-developed abdominal red belt, had a sixth spot varying in size and development, and possessed a distinct peculiarity in the broader black border (the red entering it and forming a rectangular patch at the anal angle). He expressed a suspicion, however, that *charon* was only a south-Alpine form of *A. meliloti*, as he had seen: (1) Red-belted German *meliloti* from Wasselnheim, Alsace and Kreuznach. (2) Alpine *A. meliloti* with broader margin to hind-wings and of similar form to *charon*. (3) Narrow-bordered *charon* bred from Tyrol larvæ in 1877. Frey notes [*Mitt. Sch. Ent. Ges.*, vii., p. 14 (1887)] the occurrence of *charon*, Hb., on the south side of the Simplon, and agrees that it may be a southern form of *A. meliloti*, but considers that more evidence is required. Calberla, however, unites without hesitation, *charon*, Hb., fig. 21, with *meliloti*, and writes (*Iris*, viii., pp. 213-218) : "I hold with Christ that *charon* (Hb., fig. 21, H.-Sch., figs. 69-70), and its red-belted var. *stentzii*, H.-Sch., fig. 23, is a southern six- (rarely five-) spotted form of the usually five-spotted *meliloti*, Esper, and its red-belted var. *stentzii* (Frr., pl. 278, fig. 4, *meliloti* var., H.-Sch., figs. 86-87). *A. charon* occurs commonly in the south-eastern Alps, *A. meliloti* rarely ; in the rest of Italy one only finds *A. meliloti* singly. Speyer knew *stentzii*, H.-S., from the Tyrol and Bergell, but does not mention *charon*, Hb., although it is evident (*Geog. Verb.*, i., pp. 346, 461, ii., p. 282) that he included both forms under the name *teriolensis* as a transalpine form of *meliloti*, whilst Herrich-Schäffer appears to have suspected in his *stentzii* a var. of *A. meliloti*. *Charon*, Hb., and *stentzii*, H.-S., extend from the Tyrol westward through the southern Alps to Cuneo, and onwards through the mountains of Italy to Sicily. They are of a more glossy black and brighter red, with a broader black border to the hind-wing, which is only narrower in the middle of the outer margin than in *A. meliloti* and its ab. *stentzii*, Freyer. Expanse 22-29 mm. as in *A. meliloti*. Transitional forms occur as Christ has stated. Herrich-Schäffer's figures refer to Piedmontese specimens (fig. 70 is very large and narrow-winged), whilst Hübner figures the Apennine form of upper Italy. I possess many examples from between Bologna and Pistoja, and have seen similar ones from the Ligurian Apennines, which agree with Hübner's figure and description, and differ from the south Alpine form, in being darker, more thickly scaled, and in having more rounded fore-wings, and broader bordered hind-wings. The expanse of my examples is 26-27 mm., against the 28 mm. of the figured specimen. The fore-wings of the male are deep black-blue, those of the ♀ green with strong metallic gloss. . . . . . . The fore-wings are, on the upper-side, five- or six-spotted, on the under-side the five-spotted examples show the sixth spot, and the red tinge of the Alpine specimens is lacking. If one wished to separate the south-eastern Alpine form the name *teriolensis*, Speyer, would have to be used. Staudinger has sent out the six-spotted red-belted form under the name of ab. *cingulata*, to distinguish it from ab. *stentzii*, Frr., but the name *cingulata* would fall before *decora*, Led. (*Verh. z.-b. Ver. Wien*, 1852, p. 125), the name *teriolensis* being retained for the form without a red abdominal belt. The ab. *decora*, Led., is not known to me from the Apennines of southern and central Italy. Another form of *charon* found in Italy is the Neapolitan, which flies in the Apennines in this district to about 1,000 m., at the end of June and in July, and is not very different from the Alpine form. The fore-wings are somewhat more glossy, the red more crimson than in *meliloti*, spot 4 is more often quadrate, the basal spots are more often connected. Of 12 specimens before me only one ♀ possesses the traces of a red belt, another ♀ has an indistinct 6th spot. The third form is the Sicilian, which I distinguish as var. *sicula* ; it was found in a marsh in the forest of Mistretta, at above 1,000 m. elevation, sitting on rushes projecting from water ; elsewhere in Italy *charon* flies on dry mountain pastures. The dull black is, in this form, tinged with blue or green, and is darker in the ♂, the red is a light cinnabar, fading into crimson ; the greyish-black border of the hind-wings is at the inner angle very broad. Spots 1 and 2 are mostly connected, 1 often reaches beyond the costa until beyond 3, 5 and 6 are also always confluent, and often form only a single large spot, as in *A. achilleae*, Esp., 3 retains its longish form, and is only separated from 4 by the nervure, 4 is very large, square, sometimes united with 5 and 6. Of 12 examples, one shows traces of an abdominal ring. A red suffusion unites the spots beneath. In the tint of the red colour this var. comes very near specimens from Amasia and Hadjin, but these have smaller, separate spots, greenish fore-wings, stouter antennæ, darker underside to fore-wings, and are larger; they resemble, but only in markings and the tint of red, *christophi*, Staud. To var. *sicula*, Ragusa's *scabiosae* (*Nat. Sic.*, vi., p. 237) belongs; he states that one specimen had 5, the remainder 6, spots, in part or entirely connected, whilst one ♀ had a red belt and a very narrow border to the hind-wings. Laharpe and others are reported to have taken *charon* in Sicily. Curò gives (*Bull. Ent. Soc. Ital.*, vii., p. 196) indications which suggest that his examples may refer to the forms described by me, among which everywhere 5-spotted specimens with a narrow border to the hind-wings occur which might be referred to *meliloti*; the latter, however, certainly only occurs in Italy as an aberration of *charon*." Discussing the various forms referred by himself to this species, Calberla avers that "the red increases by the formation of a sixth spot, and the black marginal border of the hind-wings (with a few exceptions) increases in width as one goes south." The upper Italian and Tuscan insect, he says, forms another exception, for "it is often 5-spotted, and yet has the widest broad border; local forms with smaller spots also possess less red colour on the underside, and the rule applies also generally to the individuals of particular races, as does also the rule that with smaller spots on the fore-wings, the black border of the hind-wings is broader. The colour and scaling vary according to the locality. The red abdominal belt appears to be commonly developed only in the southern Alps. The form of the antennæ, and the shape of the wings of individual races, show no constant difference, the trans-alpine specimens contain, on the average, longer and narrower fore-wings, and a more strongly concave margin to the hind-wings."

Ovum.—Under the microscope the egg appears of a pale yellowish colour, tinged with green, smooth, and perfectly oval, apparently varnished and laid in patches with the major axis of each egg parallel to that of the others. The eggs were mottled in places with creamy-white, and there were some black, and a few red and blue scales from the parent adhering to the surface of the egg, the whole appearance of the egg strongly reminding one of that of some birds, especially that of the yellow-hammer. The eggs hatched on July 18th, 1872 (Briggs). Bacot observes that the eggs are somewhat similar to those of *A. lonicerae*, but are laid differently, being less closely packed, and only in a single plane (not upon each other, as in that species and *A. trifolii*). Compared with the latter, they are larger, more rounded, and the sculpturing less marked. Briggs also notices that the egg of *A. meliloti* is larger than that of *A. trifolii*, and very much larger than that of *A. filipendulae*.

Habits of larva.—The larvæ hatch during July (July 18th, Briggs), and grow very slowly. They hybernate when about three lines in length, and are then of a semi-transparent brownish-white colour, the markings indistinct, giving the larva "somewhat the appearance of a maggot." After hybernation, the larvæ begin to feed in March, moulting in early April, and then quickly undergo several moults, becoming full-fed from about the beginning to the end of June. Some larvæ, however, take two years to complete their metamorphoses, that is, they hybernate two winters. Briggs reports that a brood of larvæ moulted on April 5th, again on May 27th, then on June 8th, July 9th, and July 29th, when they were about half-an-inch long. They then ceased feeding, and proceeded to hybernate for a second winter. This habit of going over two winters in the larval stage is not altogether due to temperature, since Fletcher reports that larvæ remained torpid during the unusually hot summer of 1893. The larva, even when feeding, is very sluggish, and its growth is so slow that it is possible that two years is more frequently taken for it to reach maturity than one. Barrett says that the full-grown larva is fairly active in its movements when hungry, but is usually so sluggish that another may walk over without disturbing it. Caradja observes that the larva is only found singly in sunny places, while, in the shade close by, he has obtained them in the greatest abundance from different species of trefoil, in May and until June 10th.

Larva.—The *newly-hatched* larva is of the shape of the adult, although probably somewhat more slender. It bears the generalised form of tubercles—i, ii, in the form of dorsal anterior and posterior trapezoidals, iii as supraspiracular, iv and v as subspiracular—and each tubercle bears a short whitish hair. After the *first moult* the specialised tubercular warts appear, and the larva undergoes no great structural change afterwards. When it hybernates (? *third instar*) it is very small, about 5-7 mm. in length. At this stage the following description was made under a two-thirds lens (October 1st, 1897):—The head is completely retractile within the prothorax, pale brown in colour, with dark brown markings on the cheek, the ocelli black. *Dorsal view*: The ground colour whitish, somewhat transparent and glassy-looking, is distinctly visible as a broad medio-dorsal line. The prothorax is swollen, and composed of the united warts, that are mostly separate on the following segments. These consist of (1) Two dorsal warts (one on either side of the medio-dorsal line, and formed by the junction of i and ii on each side). (2) A supraspiracular wart (iii) on each side. (3) A subspiracular wart (consisting of of iv and v united) on each side. (4) A marginal wart (at the base of each proleg, and situated at the lower margin of the lateral area). The dorsal warts are yellow in colour, and placed at the front of each segment. Each is complex in structure, bearing several long yellowish branched hairs with blackish bases, each arising from a black tubercle, that forms its base. A ring of pale hairs on the margin of each wart gives it a very radiated appearance. The large size and yellowish colour of the dorsal warts make them appear as two longitudinal lines, extending from the metathorax to the anal segment. (On the prothorax and mesothorax they are united medially.) *Lateral view*: There is a longitudinal series of supraspiracular warts, very similar to the dorsal series, each with six black tubercular points, and each of the latter giving rise to a long branched hair. The spiracles are prominent, each forming a hemisphere, slaty-grey in colour, with a densely black apical point surrounded by a whitish ring. There is another series of similar subspiracular warts, but these appear to bear only five black points, whilst a series of marginal warts of almost precisely similar size and shape is found along the base of the prolegs. The prothoracic spiracle is very distinct, situated well back, almost in the incision between the pro- and mesothorax. The warts on the thoracic segments seem almost identical with those on the abdominal segments, except that, on the prothorax and mesothorax, the dorsals unite, and the supraspiracular wart becomes rather prespiracular in position, as also does the latter on the metathorax. *Ventral view*: The head is ventral; the body surface is very pale creamy-white, the segmental incisions glassy-white; the true legs yellowish, with a single dark brown terminal claw, and a few short black hairs at the joints. The prolegs transparent, white, with an inner flange of conspicuous black hooks; the anal prolegs similar to the others, but wider. When the larva had passed four spring moults (? *seventh instar*), Briggs described it (*E.M.M.*, x., p. 117) as having the body pale greenish-grey, with a few short white hairs scattered over it, and irrorated with minute black tubercles. Head black, with the transverse upper lip, the membrane at base of antennæ, and articulations of the mouth, white. The arrangement of the ground colour is into five lines, as in *A. palustris* (*trifolii-major*), *trifolii*, *lonicerae* and *filipendulae*, but these lines are almost obsolete, though faintly distinguishable, with an indistinct, pale, narrow, dorsal streak down the centre of the dorsal line. The dorsal line is broad; on each side of it, instead of the two large black spots on each segment, more or less distinct or confluent, as in the other species mentioned, the anterior spot only is present in the form of a minute black spot on the anterior portion of each segment. Below this, on each side, is a broad line of the ground colour, with an inconspicuous chrome-yellow spot in the fold, formed by the hind margin of each segment. The lower (spiracular) row of black spots is entirely absent, being replaced by the ground colour. The spiracles black, encircled with first a white, then a black narrow ring. No dusky marks above the prolegs, nor on the underside, except a narrow black line round the base of each true leg, and the apex of each proleg. The *adult* larva is diagnosed by Esper as being pubescent, of a glaucous-green colour, with a white line running down the back, and a yellow spot, with a small black one above it, marking each segmental incision; head and legs brownish-black, the prolegs of the same colour as the body. Fletcher says that Esper's description agrees with the larva of our British insect. Barrett describes (*Brit. Lep.*, ii., p. 124) the larva as dull pale green in colour, with abundant minute black points; dorsal line broadly whitish-green, shaded off on each side; subdorsal line whitish, interrupted on each segment by a distinct yellow spot, immediately above and behind which is a distinct round black dot at the incision of each segment; spiracular line very indistinct whitish-green; ordinary raised spots green, bearing tufts of short downy white hairs; spiracles black, with white rings; legs and prolegs greenish with a blackish ring. Before full growth the colour is rather darker, and the subdorsal lines are interrupted by a very bright yellow spot on each segment. The larva is said by Hering to be much more delicately built than the other known Anthrocerid larvæ. He notes it as light greenish-yellow in colour, with fine hairs.

COMPARISON OF THE LARVA OF A. VICIÆ WITH THAT OF A. TRIFOLII.—Briggs says that the larva of *A. viciae* (*meliloti*) hybernates when much smaller (3 lines) than that of *A. trifolii* (5 to 6 lines in length). Until hybernation, there is no perceptible difference in the markings of the two larvæ, except that in the larva of *A. trifolii* the future rows of spots and lateral lines are distinct, in that of *A. viciae* they are nearly (and in some specimens quite) obsolete, giving the larva somewhat the appearance of a maggot. In April, after hybernation, *A. trifolii* moults and assumes the lateral lines with orange spots, and the two dorsal and two lateral rows of large black spots that (except in size, shape, and intensity) it possesses in common with the larvæ of *A. palustris* (*trifolii-major*), *filipendulae* and *lonicerae*. In *A. viciae* the spots and lines are so nearly obsolete that, to a casual observer, they would appear quite so, the large spots being represented by occasional dusky punctations.

COCOON.—The cocoon is fusiform in shape, rather broader at the basal end, deep yellow in colour, shiny, with several strongly developed, irregular, longitudinal ridges extending from the base to within some little distance of the apex, the latter being comparatively smooth. These ridges sometimes unite laterally, so as to form a somewhat rough, irregular reticulation. The cocoon is of a thin texture, formed of fine silken fibres closely interwoven. The inside of the cocoon appears smooth, and is much paler than the outside. Under a lens, however, it is seen that the cocoon is lined with a somewhat loose coating of almost pure white silk fibres. The torn edge suggests that the yellow colouring matter is an after addition, applied to the silk after it has been spun, being found in isolated patches in some places. The cast larval skin lies in the bottom of the cocoon. The cocoons described (for which we are indebted to Mr. Head) are very uniform in size, 19 mm. long, and 5 mm. wide at the broadest part. They are attached to pieces of grass culm, and it is reported that the cocoons are never placed at any great distance from the ground. Ochsenheimer notes that "the cocoon is parchment-like, elongated, and pale yellow in colour," whilst Esper also says that "the cocoon is elongated, and of a very pale yellow colour," and Barrett calls it "pale yellow or whitish." There is probably some variation, therefore, in the tint of the cocoons, as ours are of a quite deep yellow colour. J. P. Barrett found a cocoon attached to a grass culm, in the New Forest, in 1871.

PUPA.—The pupa is very similar to those of the other British Anthrocerids but is rather more slender than any of those known to us. *Ventrally*: The head, mouth-parts and appendages are shiny black, with fine transverse ridges crossing the appendages. The head prominent, slightly depressed frontally between the bases of the antennæ. The maxillæ are well developed, the first pair of legs are very long and also well developed, whilst the tibiæ of the second pair only are visible. The antennæ extend considerably beyond the wings. The maxillæ disappear beneath the apices of the wings and antennæ, and reappear again beyond the termination of the latter, where also the tarsi of the third pair of legs are to be seen. The whole of these are free from, but terminate at, the sixth abdominal segment, in which there is a median depression in which they rest. The abdominal incisions are well-marked, the anal segment turned back dorsally. *Laterally*: The antennæ prominent, extending beyond the costal edge of the wing, the bases of the antennæ also prominent, and forming the frontal edge of the pupa; the glazed eye smooth, forming an inconspicuous lunule, stretching from the base of the antenna to the base of the leg; the skin of the wing fine and silky-looking, the neuration very strongly defined; the abdominal incisions well marked, the cremaster rounded, apparently without hairs, and ending in a line with the dorsum. *Dorsally*: The frontal edge of the head prominent, black, with a distinct shallow depression between the two bulging bases of the antennæ. There is a very distinct separation of colour between the black antennæ and wing-margin and the pale thoracic segments. The prothorax frontal, a distinct segmental portion (dorsal head-piece) of the same pale colour as the dorsal area between the front edge of the prothorax and the antennæ. The mesothorax well-developed, swollen medially, and giving rise on either side to the fore-wings, the base and also the inner margin of which are somewhat prominent. The prothoracic spiracle is deeply embedded in the base of the incision between the pro- and mesothorax. The metathorax is very narrow medially, widening out at the sides, and giving rise to the hind-wings, which are conspicuous below and beyond the inner margin of the fore-wings. The abdominal segments 1-9 are all well-developed, with a very clearly marked intersegmental membrane between 2-3, 3-4, 4-5, 5-6 and 6-7, the front edges of segments 2, 3, 4, 5, 6 and 7 being finely toothed (or ridged) longitudinally, and giving a suspicion of being useful in enabling the pupa to force its way out of the cocoon. The cremaster forms a small, projecting, and practically smooth, cushion. A pupa examined when the imago was fully formed within gave the following details: Dorsally, the thorax and abdomen are of a pale grey colour, as also is the abdomen ventrally. The prominent head, the mouth-parts, wings and appendages are shining black. The skin is exceedingly delicate and transparent, the imaginal colours and markings showing distinctly through it. Esper describes the pupa as being "yellowish-white, with the back and the wing-covers of a blackish-brown colour." Barrett describes the pupa as having the "head, sheaths of the wings, legs, and antennæ glossy black; the whole of the abdomen and the back clear, spotless, pale yellow, the skin of the latter portion so thin, that, after the moth has emerged, there remains only a filmy transparent white pellicle. The contrast shown between the colour of the head and appendages, and the abdomen, is very remarkable."

FOOD-PLANTS.—*Lotus corniculatus* (Briggs), *Trifolium* (Kirby), *Vicia*, *Lathyrus pratensis*, clover (Kaltenbach).

HABITS AND HABITAT.—This species is very local and uncertain in its appearance. Hering mentions that, in 1839, it was exceedingly abundant nr. Damm, but that in the same locality not a larva nor imago could be found the following summer. It was first announced as a British species in 1872 (although Cox says specimens were captured in 1869), when many examples were taken in Stubby Coppice, in the New Forest. In the five following years large numbers were collected in every stage in the restricted locality first found, and it was soon practically exterminated there. It was re-discovered in a neighbouring locality in 1888, and has since been found in other spots all very near to each other. The insect is, however, worked so systematically by professional dealers and collectors, that in some years it is very rare indeed. The imago flies freely in the sun, or may be found at rest on the flowers in its habitat. Weir reports having taken it in Sussex, twenty years before it was captured in the New Forest, but its occurrence in this county has never been confirmed. There is no doubt that Hodgkinson's report that: "*A. meliloti* was formerly common near Manchester and on the railway bank near Scorton," is an error. Probably both these reports refer to the small form of *A. trifolii*. Barrett says that "it inhabits marshy spots" in the New Forest. Tugwell says that the species occurs over a fairly wide locality, *viz.*, from the top ride (just outside Ramnor), through all the upper rides of Park-hill enclosure, the ride on the Denny side of Stubby Copse, Perrywood Heath, and by the rides running parallel to the railway. Most of the ground is high, plenty of wet spots exist, but these do not seem to be at all necessary for the welfare of the species, the district where it occurs being well wooded, and plants luxuriant. It is common in woods in the Rheims district (Demaison), in an open wood near Damm, in Pomerania (Hering), in wood-clearings at Grumazesti, and in a meadow covered with bushes and scattered oaks at Kloster Neamtz. The males fly in the sunshine, whilst the females sit on low plants, usually in the most shady places, under trees and bushes, and there await the males; in the afternoon, one may there find them *in copulâ*, and sweep them in numbers with a net (Caradja).

Time of appearance.—Boisduval gives the end of June and early July, which agrees well with the time that the species occurs in Britain, and Caradja notes it from June 22nd to July 25th in Roumania, Fritsch gives June 12th-22nd, in three successive years, at Gresten, Austria, and July 12th at Salzburg; the last week in June, 1871 (Tugwell), June 29th, 1871, at Stubby Coppice (J. P. Barrett), July 9th, 1873, in New Forest (Briggs), first week in July, 1874 (Fletcher), July 6th-15th, 1874, June 20th-July 4th, 1875, nr. Brockenhurst (Bower), July 19th, 1879, in the New Forest (Auld), July, 1888, at Matley Bog (Nicholson), July 13th, 1890, in New Forest (Blagg), July 20th, 1890, nr. Lyndhurst (Robbins), June 23rd, 1895, June 25th, 1896, July 11th, 1897, July 6th, 8th, 10th, 1898, in the New Forest (Christy), July 22nd-25th, 1898, in New Forest, worn (Dadd).

Localities.—Hants: New Forest. This is the only known British locality. [Sussex: nr. Emsworth, where eggs were put down in 1896 and 1897, and imagines found in 1898 (Christy)].

Distribution.—Africa: Barbary (Wagner). Asia: Obi and Yenesei districts (Erschoff), Pontus, Armenia, Altai mts. (Staudinger). Austria: Bohemia, Vienna, nr. Klosterneuburg, Linz, Styria, Salzburg (Speyer), Möllthal in Upper Carinthia, Carniola, Meran, Buda, Thalwaldungen, Habandorf, Nazzaro, Bruck-on-Mur (Dorfmeister), Dalmatia, Hungary (Staudinger), Gresten, Salzburg (Fritsch). Bulgaria (Staudinger). Denmark: (Reuter). France: Forest d'Allogny (Sand), Dept. Doubs, nr. Pontarlier, Pagney (Bruand), Pyrenees, Cauterets, nr. the cascade of Serizet (Oberthür), Dept. de l'Aube, woods of Thouan (Jourdheuille), Rheims dist., common, Berru, Rilly, Germaine, etc. (Demaison), Saone-et-Loire (Constant). Germany: generally distributed (Heinemann), Pomerania, nr. Damm (Hering), Wismar, Gesselwitz, Frankfort-on-Oder, Taunus, Boppart (Kayser), Constance, Ueberlingen, Herrenwicz, Bergstrasse, Würtemburg, Nassau (Reutti), Prussia, nr. Dantzig, Stargard, Willenberg, Mecklenburg, nr. Gadenbusch, Lower Hartz, nr. Sternhanses, Auerberge, nr. Stolberg, Waldeck, Arolsen, Wildungen, Mülhausen, Hainiceh, Treffurth, Weimar, Nossen, Dresden, Silesia, Lissa, Scarsine, nr. Breslau, Zusselwitz, nr. Münsterburg, Stolzenfels, nr. Coblenz, Trier, Wiesen, Frankfort-on-Main, nr. Langen, Wiesbaden, Bingen, Darmstadt, nr. Arheiligen, Pfalz, Stuttgart, Augsburg (Speyer), Alsace (Boisduval), ? Barthey, nr. Bouxwiller (Peyerimhoff), nr. Hamburg (Gethard), Lüneburg, Berlin, Halle (Ochsenheimer), Helmsted (Schreiber), nr. Blakenburg (Heinemann), Jena (Schläger), Thuringia, Gotha, Siebleber Holz, Berlauch, etc. (Knapp). Italy: rather rare in northern and southern, doubtfully from the central, provinces (Curò), Piedmont, valley of Exilles, Calabria (Speyer), Sicily (Curò). Netherlands: Luxemburg (Speyer). Roumania: Grumazesti, Kloster Neamtz, Slanic, Comanesti (Caradja), Tultscha (Mann), Turn Severin (Haberhauer). Russia: Poland to Gulf of Finland, Moscow dist., Caucasus, Transcaucasia (Erschoff), Grusia (Lederer), Finland to 60° 30′ (Reuter), Kokenhusen, Riga, Kurtenhof, Reval, Pichtendahl (Nolcken), Livonia, Volga dist., on the steppes (Speyer), Baschkiriæ (Eversmann). Scandinavia: Sweden and Norway to 67° 50′ (Reuter), Stockholm (Aurivillius), Blekinge (Wallengren), West Gothland (Boheman), Olleberg (Dalman), Westmannland (Fredricksson). Switzerland: nr. Zürich (Frey), Blumenstein, foot of Stockhorn (Meisner), Basle, Dorneck (Peyerimhoff), Tarasp (Killias), S. Gallen (Täschler), Dusnang, at 1847 ft. (Frey), Schaffhausen (Trapp), Bremgarten (Boll), Oftringen (Wullschlegel), Liesthal, Pilatus (Christ), Valais, Viège, Leuk (Jäggi), Saas Thal (Stehlin).

[Some of the above localities must be considered with discretion. There is little evidence to show that the insect we call *A. viciae* is known south of the Pyrenees and Alpine ranges.]

ANTHROCERA LONICERÆ, Scheven.

SYNONYMY.—Species: *Lonicerae*, Scheven, "Naturforscher," x., p. 97 (with reference to Schäffer, "Icones," pl. xvi., figs. 6-7) (1777); Amstein, "Fuessly's Mag. Ent.," i., p. 125 (1778); Fuessly, Ibid., i., p. 140 (1778); Esp., "Die Schmett.," ii., 1st pt., p. 183, pl. xxiv., figs. 1*a*, *b* (1781); ii., 2nd pt., p. 12, pl. xxxix., figs. 9-14 (1789); Bork., "Sys. Besch.," ii., pp. 20, 161 (1789); "Rhein. Mag.," i., pp. 303, 633 (1793); Hb., "Eur. Schmett.," ii., fig. 7 (1797), p. 80 (? 1805), fig. 160 (? 1818); "Verz.," p. 117 (? 1822); Ochs., "Die Schmett.," ii., p. 49 (1808); Bdv., "Mon. des Zyg.," p. 56, pl. iii., fig. 8 (1829); Freyer, "Neuere Beiträge," v., pl. 446 (1845); Evers., "Fauna Lep. Volg.-Ural.," p. 96 (1844); Assmn., "Abbild. Schmett. Schles.," ii., p. 20 (1845); H.-Sch., "Sys. Bearb.," ii., p. 36 (1845); Kayser, "Deutsch. Schmett.," p. 168 (1852-9); Sta., "Man.," i., p. 81 (1857); Speyer, "Geog. Verb. Schmett.," i., p. 347 (1858); Hein., "Schmett. Deutsch.," i., p. 160 (1859); Wallgrn., "Skand. Het.-Fjär.," p. 104 (1863); Lucas, "Hist. Nat.," 2nd Ed., p. 154 (1864); Nolck., "Lep. Fn. Estl.," i., p. 99 (1868); Newn., "Brit. Moths," p. 24 (? 1869); Briggs, "Trans. Ent. Soc. Lond.," p. 418 (1871); Staud., "Cat.," p. 47 (1871); Frey, "Mitt. Schw. Ent. Ges.," iv., pp. 224-225 (1874); "Lep. der Schweiz," p. 68 (1880); Curò, "Bull. Soc. Ent. Ital.," vii., p. 197 (1875); Kirby, "Eur. Butts.," etc., p. 90, pl. xxi., figs. 7*a-c* (1879); "Cat. Lep. Het.," p. 69 (1892); "Handbook," etc., pp. 91-92 (1897); Sand, "Cat. Lép. Auv.," p. 23 (1879); Peyer., "Cat. Lép. Als.," p. 47 (1880); Oberth., "Lép. Pyr.," p. 31 (1884); Buckler, "Larvæ," etc., ii., p. 18, pl. xix., fig. 3 (1887); Auriv., "Nord. Fjär.," p. 53 (1888); Hofm., "Die Gross-Schmett.," p. 35 (1887); "Die Raupen," etc., p. 36 (1893); Hewett, "Ent. Record," i., p. 59 (1890); Barr., "Lep. Brit.," ii., p. 130, pl. lxi., figs. 3 *a-d* (1894); Meyr., "Handbook," etc., p. 448 (1895); Caradja, "Iris," vii., p. 73 (1895); Tutt, "Brit. Moths," p. 352 (1896); "Ent. Rec.," ix., pp. 87, 166 (1897); Oberth., "Var. chez Lep.," p. 46 (1896). *Fulvia*, Amstein, "Fuess. Mag. Ent.," i., p. 114 (1778); Fuessly, Ibid., p. 139, pl. i., fig. I (1778); Schrank, "Fuessly's Neues Mag.," ii., p. 207 (1785); Fab., "Mant.," ii., p. 101 (1787); View., "Tab. Verz.," p. 24 (1789). *Graminis*, De Vill., "Ent. Linn.," ii., p. 115 (1789). *Loti*, Fab., "Ent. Sys.," iii, p. 387, *teste* Ochs. (1793); Schrank, "Faun. Boica," ii., p. 240 (1801); Haw., "Lep. Brit.," p. 74 (1803); Stephs., "Illus.," i., p. 109 (1828).

Notes on original figure.—Schäffer (*Icones*, pl. xvi., figs. 6-7) figures without a name an *Anthrocera*, which might represent almost any five-spotted species of the genus. Scheven refers to these figures, and names them *lonicerae*; this makes them, Kirby says, the typical figures. Werneburg holds these to represent *A. lonicerae*, and Kirby adds that "the border of the hind-wings is very narrow." All Von Scheven says of *A. lonicerae* is that it differs only from *A. filipendulae* in having five red spots, and that he would have considered it to be its ♀, but that he had often found both species *in cop.* and that they always paired true. Fuessly figures (*Mag. Ent.*, pl. i., fig. I) under the name of *fulvia*, a large form of *A. lonicerae*, whilst Esper figures (pl. xxiv., figs. 1*a* and 1*b*), under the name of *lonicerae*, the two sexes of the species we know by this name (the underside of the male with a long costal streak, uniting the upper basal and central spots, and with the lower spots absent on the left side).

Imago.—Anterior wings 24-39 mm., of a deep green or blue-green tint, with five bright crimson-red spots. Posterior wings red with a narrow blackish-blue margin.

Sexual dimorphism.—The female is, as a rule, much larger than the male, whilst the marginal border of the hind-wings is broader in the male than in the female. The ground colour of the fore-wings is usually purplish-green in the male, green in the female, but this colour distinction is by no means an absolutely constant sexual difference, since some males are as green as the females.

Variation.—The tendency to maintain a fixed type and the general absence of blotching (such as occurs in *A. trifolii*) are, in this species, most marked, not only in Britain but on the Continent. The authority of Herrich-Schäffer, Ochsenheimer, Doubleday, Oberthür and others, all point to this fact. We have, ourselves, examined hundreds of examples from Kent, Aix-les-Bains, Cortina, and the Mendel Pass, without meeting with an aberration worthy of notice. There is, however, some variation in size, the males, in Kent, measuring from 22 mm. to 37 mm., the females from 29 mm. to 39 mm. A large race is permanent in many localities, and has been named var. *major* by Frey. On the other hand, small individuals are constantly met with, some measuring not more than 22-25 mm. = ab. *minor*, n. ab. There is very little doubt that the ab. *eboracae*, Prest, is a pathological result. In some examples the red tends to be orange = ab. *lutescens*, Hewett, in others pink = ab. *miniata*, n. ab., or yellow = ab. *citrina*, Speyer. Porritt notes a specimen with the dark portion of the fore-wings of a rich blue, shot with purple, Mason one, wholly bronze without a trace of blue, the blue margin to the hind-wings being similarly modified, whilst we have examples in which odd wings are pallid and practically without pigment. Auld has recorded an example with subdiaphanous wings, and Bromilow captured, in June, 1892 (? Alpes-Maritimes), a specimen of this species in which the left wings are normal, both in size and markings, but the right wings dwarfed and very misshapen, and with an extra elongated spot on the inner margin near the base. The ab. *chalybea*, Meves, is one in which the red is suffused and has become dark brown in colour, a form exactly parallel with *A. filipendulae* ab. *chrysanthemi*, etc. Such variation as takes place in the spotting is rather constant, and has been already described (*ante*, p. 425). The tendency for 1 to form a long wedge-shaped streak along the costa = ab. *cuneata*, n. ab. (*? cytisi*, Frr., *Neu. Beit.*, pl. 164, fig. 4), has been occasionally noticed. The form in which all five spots are united was first figured by Hübner as *achilleae*, the most extreme form in this direction being one recorded by Peyerimhoff as having the fore-wings entirely red. Robson records a specimen bred from a York pupa, intermediate between ab. *achilleae* and ab. *cuneata*. It has the costal spot, 1, forming a long streak beyond, but not confluent with, the upper spot of the central pair, whilst the lower spot of the central pair (on the left wing only) is connected with the lower basal spot by a suffused streak. The lower central spot is similarly connected with the fifth (outer, apical) spot, also on the left wing only. On both wings, the fifth spot is extended towards the anal angle, considerably farther than usual. We have seen a specimen in which the anterior wings have 2 joined to 4, and 3 only just separate from 5, thus approaching the *trivittata* form of *A. trifolii*. Caradja notes one from Roumania with 5 + 3 united. Aberrations with three longitudinal markings (1, 2 + 4, 3 + 5) might be called ab. *trivittata*, n. ab. Occasionally a specimen occurs with the two central spots (3, 4) united, but the aberration is very rare in this species; this form we call ab. *centripuncta*, n. ab. We have also seen specimens with a small supplementary sixth spot between 3 and 5; two such examples are in the British Museum collection. Costa records a Neapolitan form of the species with smaller spots than usual, and Boisduval notes a similar race in Normandy, but his reference to the spots being "as small or even smaller than those of *A. filipendulae*," is rather inexplicable, as the spots of *A. filipendulae* in this country are usually of good size, quite as large as those of *A. lonicerae*. Klemensiewicz notes an example of *A. lonicerae* that emerged with only one antenna. Although, as we have just pointed out, *A. lonicerae* is characterised by its attempt to maintain a fixed type, yet it must not be supposed that there is an entire absence of local races. We have already referred to the var. *major*, Frey, which is really only a large variety, but with otherwise characteristic and normal facies. If, as we suspect, *A. medicaginis* is a highly differentiated southern form of this species, we have, in its deeper coloration and more metallic appearance, an almost parallel development with that observed in *A. charon*, Hb., which Calberla unites (*ante*, p. 458) with *A. viciae*. Very similar to Frey's var. *major* is the fine large form which Johnson obtained at the Mullinures in Armagh, although the most striking local form we have in Britain comes from Filey, on the Yorkshire coast. In this race, the measurements of which extend from 34½ mm.-39 mm , the fore-wings are broader, the ground colour deeper, the red spots and hind-wings of a richer tint, than in the type, and the hind margin to the hind-wings is also exceptionally broad, characters rarely seen in the examples from other British localities represented in our collection, and all reminding one somewhat of the southern *medicaginis*. For this race we suggest the name *latomarginata*, n. var., owing to the broad margin of the hind-wings which characterises it.

α. ab. *semilutescens*, Hewett, "Ent. Record," i., p. 60 (1890).—Base of posterior wings orange. York.

β. ab. *lutescens*, Hewett, "Ent. Record," i., p. 60 (1890).—Two posterior wings orange.

The specimen, bred by Mr. Hewett, from which this aberration was named, is an isolated example, in which the red pigment of the hind-wings has largely failed. The wings are of an undefined orange-red colour, fading to yellowish on the outer margin.

γ. ab. *citrina*, Spey., "Stett. Ent. Zeit.," xlviii., p. 334 (1887). *Flava*, Oberth., "Etudes d'Ent.," xxth. liv., p. 43, pl. viii., fig. 148 (1896).—Agrees exactly with typical German *A. lonicerae*, except in colour. The size is the same, the apex of the fore-wings sharply pointed, the margin oblique, the ground colour inclining to green. The spots and hind-wings of a clear light yellow, between straw- and citron-yellow, on the underside scarcely any paler (Speyer).

This form was first mentioned by Ochsenheimer, who writes: I possess an aberration, which, instead of red, is of a very beautiful yellow colour; a similar is found in Gerning's collection (*Schmett. von Europa*, ii., 52). Speyer, who first described the form "with yellow spots and hind-wings" as ab. *citrina*, remarks that the specimens described by him were taken in Silesia, by Teicher, who found single examples in different years until 1887, when he captured some 20 examples and three transitional ones. This was the first time that the transitions had been noticed, and they were still much rarer than the true aberration. He further notices that the aberration was a little later in emergence than the type form. Caradja observes that it has occurred in Roumania, Bellier-de-la-Chavignerie has captured it in the Cevennes, and Killias near Tarasp.

δ. ab. *chalybea*, Meves (? M.S.); Auriv., "Nordens Fjäril.," p. 53 (1888).—Fore-wings strongly bluish, spots and hind-wings dark brown, the outer margin of the latter bright cobalt-blue. Found on the rocky shores of Upland, by J. Meves.

ε. ab. *achilleae*, Hb.-Gey., "Samm. Eur. Schmett.," fig. 165 (1841). *Bercei*, Sand, "Cat. Lep. Auv.," p. 23 (1879). *Confluens*, Selys, "Bull. Ent. Soc. Belg.," xxvi., p. cxiii (1882).—Hübner's figure has no descriptive letterpress. It represents an aberration of *A. lonicerae*, with spot 1 extended along the costa for some distance, 3 is joined to 4, 2 joined to 3 + 4 by a fine upper line, and a fine central one; 5 enlarged and joined to 3 + 4 centrally by a thick red line. The fore-wings have the shape of undoubted *A. lonicerae*, and the hind-wings are quite typical of this species.

Blotched examples, in which all five spots are united, are, in this species, comparatively rare. Oberthür records one in which the spots are confluent on the left fore-wing, and separated on the right. Sand notes *bercei* as a rare aberration from Nohant, in which all the spots of the fore-wings are confluent. Oberthür has obtained one blotched example of this species only—from Cauterets, where the type is very common, and Speyer one on the Rigi, among numbers of the type; an example with entirely red fore-wings is recorded from Soultzmatt, by Peyerimhoff. Boisduval writes that the form with an irregular band is very rare. British localities are York (Hewett), Chattenden (Bower), Wyre Forest (Abbott); several others are in British collections labelled "Coventry," but we know nothing of the captor of these. Selys states that he has received from Halloy a single example, in which the basal spots are united with the median and with the posterior by a band.

ζ. ab. *eboracae*, Prest, "Entom.," xvi., p. 273 (1883); "Proc. Ent. Soc. Lond.," 1883, p. xxviii.—Not quite so robust in appearance as *Zygaena lonicerae*. The anterior wings look a little more pointed than those of that species, their colour is steel-blue, and they are more sparsely covered with scales than are those of *Z. lonicerae*; posterior wings and spots pink, not crimson; the border of the posterior wings is brown, not black; and the cilia of all the wings whitish, instead of black, as in

Z. lonicerae, *Z. trifolii* and other species of the same genus; antennæ seem rather finer. It is altogether a very curious-looking insect (Prest).

Prest bred a specimen during the last week of July, 1883, and the following day captured six others on the ground from which the first pupa had come at Sandburn, near York. He himself considered that it might be a good local form of *A. lonicerae*. When on the wing it had a washed-out appearance. Porritt, at the time, suggested that the aberration was possibly due to a diseased condition of the larvæ, and stated that he had bred similar examples of *A. filipendulae*.

η. ab. *major*, Frey, "Lep. der Schweiz," p. 67 (1880); "Mitt. Schw. Ent. Ges.," vii., p. 15 (1887). *Lonicerae*, Hb.-Gey., "Eur. Schmett.," fig. 160 (1841).—Larger, deeper blue-black in colour, brighter red; black marginal border of hind-wings broader. The large form usually with pointed fore-wings and broad marginal border to hind-wings, has been found by Meisner in Cantons Tessin and Wallis; it is abundant in the Visp Valley, *e.g.*, in 1869, near St. Nicolas. Trapp also met with this insect in Wallis, and Rätzer in the Baguethal there. Specimens also from Chur were in Caflisch's collection, and at Bergün they appear more like normal *A. lonicerae*. Near Zürich, I captured a specimen with confluent spots, and Killias found a yellow one near Tarasp (Frey).

This large form of *A. lonicerae* is pretty generally distributed in the warm valleys of Piedmont, Savoy and Switzerland. We have taken it abundantly at Aix-les-Bains, St. Michel de Maurienne, etc. It also occurs in the Austrian Tyrol. Christ records it from Bar on Mt. Cenis, the largest maesuring 42 mm., with large red spots and broad hind marginal border to hind-wings (*? medicaginis*). Staudinger notes that some large and very bright-coloured specimens, which he received from Parnassus and Veluchi, he at first referred to his var. *dubia* (with certain *angelicae*, *stoechadis* and alpine *filipendulae*), but afterwards determined that they belonged here. Hübner's (Geyer's) fig. 160 appears to be referable to this form. Caradja notes the Roumanian specimens as large, with deep steel-blue fore-wings, the red spots often quite small. In Britain the finest specimens approaching this form come from the Mullinures in Armagh. Those from Filey, on the Yorkshire coast, more closely approach *medicaginis*.

(?) θ. var. *medicaginis*, Boisduval, "Mon. des Zyg.," p. 66, in part, pl. iv., fig. 5 (1829); Dup., "Hist. Nat.," supp. ii., p. 74, pl. vi., fig. 6 (1835); Tutt, "Proc. Sth. Lond. Ent. Soc.," 1894, pp. 107-111; "Ent. Record," etc., ix., pp. 168, *et seq.* (1897); Oberthür, "Bull. Soc. Ent. France," 1898, p. 23. *Charon*, Bdv., "Icones," p. 61, pl. liv., fig 9 (1834). *Stoechadis*, H.-Sch., "Sys. Bearb.," fig. 45 (1845). *Dubia*, Staud., "Cat.," p. 21, in part (1861); "Cat.," p. 47, in part (1871); Christ, "Mitt. Sch. Ent. Ges.," vi., p. 43, in part (1880); Oberth., "Lép. des Pyr.," p. 31 (1884).—Alis anticis saturate cyaneis vel virescentibus, maculis quinque minutis sanguineis; posticis rubris margine latiore cyaneo = *medicaginis*, Bdv., *Mon. Zyg.*, pl. iv., fig. 5. A little larger than *A. filipendulae*. Habitat: the Alps of Piedmont, etc, (Boisduval).

Boisduval himself differentiated (*Icones*, p. 61) under the name of *charon* (*nec.* Hb.), the 5-spotted insect here described, from a 6-spotted species (? *ochsenheimeri*, Zell.), which two species he had united in the *Monog. des Zygénides*, p. 64. The same combination was made by Staudinger, whose *dubia* (*Cat.*, p. 47) diagnosed as: "var. major, al. ant. macul. 5 vel. 6, al. post. latius nigris," includes both the five-spotted *charon*, Bdv., and the six-spotted *ochsenheimeri*, Zell., his *dubia* coming from the "southern Alpine valleys, Pyrenees and ? Greece." In the *Proc. Sth. Lond. Ent. Soc.*, 1894, pp. 107 *et seq.*, we have pointed out how easily such an erroneous combination may be made, and we find that Oberthür, who has kindly sent us the two insects (as *dubia*) from the Pyrenees, also unites them under the same name in the *Lép des Pyrénées*, p. 31. The latter is still disinclined, we believe, to see in the five-spotted *dubia* of the mountains the same species as the insect from the environs of Nice, which Boisduval, Duponchel, and others, have figured under the name of *medicaginis*. His paper (*Bull. Ent. Soc. France*, 1898, p. 22) on the Nice specimens is the most recent authoritative essay on this species (or variety). He says: "This is the species of which Duponchel says (*Hist. Nat.*, supp. ii., p. 74) that since his journey into Italy, he has found this *Zygaena* abundant in a field near Nice." He then goes on to state that he has now before him "about 160 specimens, captured in May, around the station at Var; amongst them is a yellow aberration. The species varies much; in about 20 examples the hind-wings are widely bordered with steel-blue, or even overrun with this colour, so that only a little red remains at the base, and a red point beyond; other specimens, on the contrary, have the steel-blue border very narrow, and differ little in appearance from *A. dubia* and *A. lonicerae*. Usually this Nice form of *medicaginis* has three well-separated red spots on the upper wings, besides the basal spots; they are often very small, rarely large, and generally of a bright colour. Not a single specimen of the 160 has the spots confluent. A single ♀ shows a fourth supplementary red spot. It also flies in June in a higher locality in the vicinity of Turbie. I have 140 specimens from this locality, seven have four red spots on the upper wings (besides the basal), three have the fourth spot rudimentary, and only shown by some red scales. The hind-wings vary in the same direction (*viz.*, by the spread of the marginal border) as in the Var specimens. This form of *A. medicaginis* occurs also near Digne, where it flies in May and appears very rare. I have only two examples, both of which have the lower wings largely tinted with blue. Boisduval has figured (*Mon.*, etc., pl. iv., fig. 5) the *medicaginis* of Nice and Italy." We have obtained the insect also in the mountains of Piedmont, but at a higher elevation, and hence later in the year; August 1st-12th, 1894, at Courmayeur, Val Chapy, near Cogne, etc.; August 4th-15th, 1898, at Pré St. Didier; whilst Chapman obtained it near Mendel Pass in the Tyrol, throughout the early and middle part of July, 1895, where quite typical *A. lonicerae* occurred abundantly about a fortnight after *medicaginis* was over. Christ has the insect from the Tyrol, Macugnaga, and the southern slope of Mt. Cenis. He notes it as "a glossy insect, the dark margin of the hind-wing reduced to a narrow margin, the red portions of the wings brighter, and the dark parts more metallic." This he considers as "intermediate between *stoechadis* and typical *A. lonicerae*," and points out that Staudinger has wrongly referred *dubia* to *lonicerae*, which, in spite of its close connection with *A. lonicerae*, is itself the centre of a circle of small, reduced forms. He then traces a connection geographically between dark southern and lighter central European forms: (1) *Stoechadis, dubia, lonicerae*. (2) *Seriziati, syracusia, trifolii*. These he considers parallel series in the two species. He further agrees with Frey (*Lep. der Schweiz*, p. 67), who considers "*dubia* to be a northern form of *Z. stoechadis*, Bkh.," but Frey, however, does not suggest for it a relationship with the large *A. lonicerae* var. *major*. We should be inclined to agree in maintaining this *(medicaginis)* as a distinct species, and place it here only as an expression of ignorance. Certain it is that it is not a var. of *A. trifolii*, as suggested by Staudinger

(*Cat.*, p. 47), and Staudinger himself acknowledges this, for he writes (*Hor. Soc. Ent. Ross.*, vii., p. 103) that his *dubia* is a mixture of "large, brightly-coloured Alpine *A. lonicerae*, large, brightly-coloured Alpine five and six-spotted *A. angelicae*, *A. stoechadis* with narrow hind-marginal borders to hind-wings, and *A. filipendulae* of unfamiliar aspect." Truly a strange mixture! We examined above 100 pairs of coupled *A. medicaginis*, at Pré St. Didier, in August, 1898. In none was there the slightest trace of a sixth spot, and all were paired true. About a mile farther up the Dora valley, *A. ochsenheimeri* was moderately abundant. We examined, here, also a great number of paired examples, and all were paired true, although *A. medicaginis* occurred on this ground also. It is difficult to distinguish some males of *A. ochsenheimeri* from those of *A. medicaginis*, owing to the small size (sometimes almost entirely absent) of spot six in the former, but the sixth spot is always present on the underside in *A. ochsenheimeri*, and never, in our experience, in *A. medicaginis*. That these two insects should exist side by side without any real modification, over a range of alps extending from the Little St. Bernard to the Mendel Pass (possibly beyond in both directions), says much for their distinctness, and the fact that typical *A. lonicerae* (indistinguishable from British specimens) occurs in the greatest abundance two or three weeks later than the larger *A. medicaginis*, practically on the same ground, in the Mendel Pass, is also highly suggestive that *A. medicaginis* is specifically distinct from *A. lonicerae*. Herrich-Schäffer's *stoechadis* appears to represent the most extreme form of the species, so far as the development of the hind-marginal border of the hind-wings is concerned, the margin itself being very wide, and the dark shading extending over two-thirds of the wing. It bears most resemblance to some examples from Nice (Le Var), sent to us by Oberthür. The following notes on the ovum of *A. medicaginis* were made from eggs laid by a ♀, captured at Pré St. Didier, August 7th, 1898, and examined with a hand-lens only: Large, oval in outline, length : breadth : height : : 3 : 2 : 1½ (about), a somewhat large irregular depression on the upper surface. Colour of an uniformly pale straw-yellow. The eggs were laid regularly, side by side, in alternate rows, the base (end opposite micropyle) of one egg filling up the space between the micropylar ends of two other eggs in the adjacent row. Thanks to M. Oberthür, we have been able to examine the cocoon and pupa-case of a specimen of this race (or species) from Vernet-les-Bains. The former is 31 mm. long, 6 mm. wide, of a full yellow colour, of the ordinary shape peculiar to the cocoons of this group. The pupa-case is remarkable in being uniformly of a very pale brown colour, the thoracic and abdominal segments and the head parts being of the same tint. Structurally the pupa presents no differences from so many of its allies.

Ovum.—The eggs are laid in batches side by side, and just in contact with each other. The egg appears uniformly bright yellow in colour to the naked eye, but under a two-thirds lens the basal third is seen to be quite transparent, the other two-thirds yellow. The egg is oval in outline, length : breadth : : 3 : 2. A shallow oval depression on the upper surface, placed almost centrally. The portion of the egg underlying the depression rather opaque whitish-yellow, due probably to the reflection of light from the sloping surface of the depression. The egg-shell itself is minutely pitted, but the pits do not appear to form any regular pattern by which the reticulation may be characterised. The micropylar area forms a rather projecting area at the non-transparent pole of the egg. It is very thickly pitted, and centrally contains a small depression which forms the micropyle proper, and which is not, in general appearance, very different from the ordinary surface of the egg. [Eggs received from Mr. Ovenden, on July 12th, 1897, described under a two-thirds lens the same day.]

Habits of larva.—The newly-hatched larva usually feeds up much more rapidly than its congeners, and, by the end of September, when it prepares to hybernate, is already in its fourth instar, and of moderate size, at least twice as large as the hybernating larvæ of *A. filipendulae* and *A. viciae*. In early spring it commences to feed again, and whilst most of the larvæ make good progress, and become full-fed towards the end of May, others do not moult at all, but, remaining very small, become dormant in early summer, and pass the whole summer and another winter in this condition, feeding up in due course the following spring. The cocoon is spun on a grass culm, flower-stalk, twig of a tree, or similar object. We have seen them abundantly on ash saplings at a height of from 10 to 12 feet from the ground.

Larva.—The *newly-hatched* larva is of the shape of the adult, short, stout, with the segmental incisions very marked; it tapers rapidly at both ends. The head is black, shiny, and appears very small, although this is largely due to its being partly retractile within the prothorax. The body is pale yellowish with a double row of brown blotches, one blotch being placed on either side of the medio-dorsal line on each segment. The skin itself is covered with a fine coat of minute black spicules. The tubercles are small, in comparison with the hairs which rise from them, but are distinct, each forming a blunt cone, shiny, with a chitinous appearance. The tubercles each give rise to one very large, stout, curved, thorny hair. Dorsally, tubercles i and ii are placed as anterior and posterior trapezoidals, not only on abdominal, but also on the 2nd and 3rd thoracic segments. There are a supraspiracular (iii) tubercle and two subspiracular (iv and v) tubercles, v being almost vertically below iv. The anterior trapezoidals bear black hairs, the posterior white; the supraspiracular bears black, and both subspiraculars white, hairs. There are some secondary hairs on the thoracic segments, inconspicuous on the prothorax, owing to the retraction of the head. In the *first instar* the hooks on the prolegs have the appearance of being on the posterior face of the proleg, and are only 3 (?) in number. In the *second instar* the larva tapers rather more from the thorax to the abdomen. It is darker as a whole, and this darkening is due to the enlargement of the dark dorsal blotches into broad longitudinal dorsal bands, darkest on the posterior portion of each segment; the bands are well separated by a broad medio-dorsal stripe of the ground colour. The tubercles are very different in their arrangement; the trapezoidals, as such, are practically lost, the anterior and posterior on each side being united into a large wart, bearing about six tuberculate hairs. There is now, also, a dark supraspiracular band on either side, and this includes the supraspiracular tubercles, which have now become, on each segment, a complex structure bearing five tuberculate hairs, whilst below the spiracles, tubercles iv and v are united into a common mass, also bearing five tuberculate hairs, and, below this again the marginal tubercles show as a smaller wart on each segment, at the base of the proleg. A few of the dorsal hairs are black, the others white, but all are roughened or thorny. The larva hybernates in its *fourth instar*, and has ceased feeding by the end of September. The following description was made September 30th, 1897, from a larva already dormant. *Laterally*: Of a transparent whitish colour with a faint creamy tint. A series of supraspiracular warts, consisting of a raised white, glassy-looking base, bearing twelve or more dark-brown points, each giving rise to a branched hair, which sparkles like spun glass. Before and behind each of these warts is a transverse brown patch; these patches define the longitudinal bands, and give the larva its colour. The prothoracic spiracle is prominent, consisting of a black elevated tube, resembling a projecting piece of pipe set in a shallow basin with a prominent rim. The abdominal spiracles are similar, but larger, less distinctly projecting, that on the 8th being very large and prominent. Each of the subspiracular warts consists of a raised glassy-looking cushion, bearing fifteen dark raised points, from each of which arises a hair, similar to those of the supraspiracular series. The subspiracular wart is placed in the position of a prespiracular on the prothorax. The subspiracular series is more or less united into a prominent lateral flange; the marginal series is less prominent, and placed along the edge that separates the lateral from the ventral area, *i.e.*, along the base of the prolegs; they are also smaller, and bear only about eight points and hairs. *Ventrally*: The true legs are shiny, whitish-yellow, almost transparent, with a single, pale brown, curved, terminal hook. The prolegs are of the same pale colour, with an inner flange bearing a series of short, stiff, black, curved hooks, spread out like an open fan. *Dorsally*: There is a broad mediodorsal line of the pale whitish, glassy-looking, ground colour. On either side of this, each segment bears a long, transverse, complex, tuberculate mass readily separable into two portions—(1) The anterior, bearing five brown points, each with a radiating and finely branched hair. (2) The posterior with seven similar, hair-bearing points, arranged in a circle with one placed centrally. Each of these warts is edged anteriorly and posteriorly with a sepia-brown patch, the anterior patch being broader than the posterior and edged on its front outer margin with black. The tips of many of the dorsal hairs are black, and the dorsal hairs, as a whole, are darker than the lateral. The segmental incisions are clearly indicated, and separate the quadrangular markings on successive segments. The incisions are dorsally, if anything, paler than the rest of the ground colour. Between the dorsal and the supraspiracular series of warts, the segmental incisions are of a bright yellow colour, forming, on either side, a series of eleven conspicuous yellow patches, the first being between the pro- and mesothorax. The pro- and mesothoracic dorsal warts are not separated from each other by the mediodorsal line, as are those on the abdominal segments, but are united centrally into one mass. The tenth abdominal segment has the dorsal warts well developed, but they are united centrally. There is a suspicion of an eleventh abdominal segment in the anal flap, which bears its own modified tubercles, and is clearly separated from the tenth abdominal. *Head*: The head is entirely retractile within the prothorax, which extends over it as a complete hood of a whitish colour, transparent and glassy-looking, with the tubercular warts united, and covering its whole area. The head itself is pale yellow, the labrum white, the clypeus separated by a rather dark suture from the cheeks, the maxillæ are red-brown, the other mouth-parts are pale brown or yellowish, the antennæ prominent, pale yellow in colour, with a whitish base; the ocelli large and intensely black, forming a prominent patch on each cheek. The *full-grown larva* is described by Buckler as being nearly an inch in length, very plump, with the segments deeply divided, the head being small and retractile, black and shining; the mouth ochreous-yellow margined with black; the palpi yellow at their bases with black tips; the anterior legs black; the ventral prolegs of the ground colour of the body, a velvety bluish-green. Longitudinally, there are subdorsal and spiracular rows of black velvety blotches, and between them, at the end of each segment, a transverse, pale yellow, semi-transparent, oblong mark. Laterally, the subdorsal black blotches are seen to consist of a thick oval blotch, followed by a thinner reniform blotch on each segment, the former being placed on the anterior part of the segment. The spiracular row follows a similar order, but the blotches are thinner, and more of a curved wedge form, with a tendency to unite below. Above the legs is a fine longitudinal interrupted black line. The warts are green, and bear fascicles of short whitish hairs. A *second form* of the larva is described by Buckler as having the green ground colour a little paler and yellower than the previous form. The subdorsal black blotches consist, on each segment, of a thick, irregular, oblong blotch, placed anteriorly, followed by another, similar in shape, but rather thinner below. The spiracular row is rather shorter, but similar, more pointed, however, at the top, and meeting below by means of a curve from the anterior blotch, the hinder blotch having a little tail at the bottom. Above the feet is an interrupted black line. The true legs are black, the ventral prolegs broadly ringed with black above, their extremities tipped with black. Briggs emphasises (*Trans. Ent. Soc. Lond.*, 1871, pp. 438-439) the following characters in the larva of this species: (1). Body with *long* white hairs scattered over it, with some black hairs mixed with the white on the back; hairs much longer and more dense than in the other species of Anthrocerids. (2). Below the black dorsal spots a narrow pale longitudinal line, with a *very conspicuous bright yellow transverse spot* in the fold, formed by the hind margin of each segment. Below this line is another (spiracular) row of black spots on each side, two on each segment, *united* at their lower extremities, the posterior spot emitting a small transverse spot towards the prolegs = the "little tail" of Buckler. (3). The subspiracular is a narrow lateral line. Boisduval diagnoses the larva as follows: "La taille de celle de la *filipendulae*. Elle est d'un vert pomme, et elle a, sur chaque côté du corps, deux bandes noires formées de taches interrompues par les incisions: ces bandes s'étendent de la tête à l'anus, et l'inférieure est plus étroite. On remarque sur chaque anneau un point jaune placé entre les deux bandes; le corps est pubescent, comme dans toutes ses congénères" (*Mon. des Zygén.*, p. 58).

Cocoon.—Attached to a grass culm, flower stalk, or twig of a tree. It is fusiform in shape, with a narrow base, the silk not always extending round the twig to which it is attached. The cocoons vary much in length, from ·75 of an inch to considerably over an inch. The cocoons are shiny, very smooth at the bottom, ribbed somewhat centrally and at the top. They are thin, the pupa showing faintly through, and the silk varies in colour from a deep yellow to a pure white, nor is the colour at all uniform in the same cocoon, some parts oftentimes being much paler than others. Parasitised larvæ usually spin the palest cocoons. The inside of the cocoon has a thin layer of flossy white silk. The cocoon dehisces for the emergence of the pupa at its upper end, the opening being usually of a roughly circular form. The empty pupa-case is left projecting from the cocoon. Boisduval says: "La coque est allongée, en forme de bateau, et d'un jaune paille. On la trouve souvent attachée aux tiges des graminées."

Pupa.—The pupa is of a shiny black colour, with prominent head-piece, the maxillæ extending to the 6th, the third pair of legs to the end of the 5th, abdominal segment, and free, a distinct waist at the 4th abdominal segment, the cremaster turned back dorsally, the ♂ pupa with abdominal segments (? 1-2) 3-7 free, the female with (? 1-2) 3-6 free. The 3rd pair of legs, which run beside and outside the maxillæ, are only just shorter than the latter, and about 2·4 mm. beyond the wings; the wings and appendages being quite free; their relations to the segments vary with the position of the pupa, but there is a depression for their accommodation almost to the hind margin of the 6th abdominal segment. *Dorsally*: the head-piece projects beyond the prothorax, which is narrow; the mesothorax well-developed, with two dorsal ridges, rounded at its posterior edge, and with a distinct shoulder at the base of the wings; the grooving of the dorsum of the mesothorax is very deep, and the sculpturing of the metathorax very strong. The metathorax is narrow centrally, wider laterally; the hind-wings project much beyond the inner margin of the fore-wings. The 1st and 2nd abdominal segments depressed somewhat centrally, the 3rd, 4th and 5th segments also with a median, transverse depression, and with a ring of black hooks running round the anterior edge of these segments, those on the 4th, the point of rest for the emerging pupa, being most strongly developed; from the 5th-7th they are little more than highly developed, short, longitudinal ridges, on the 8th and 9th abdominal segments, they are small black points, similar to those on the cremaster, but less dense, and fewer in number. The cremaster turns back dorsally, has its spines developed quite to the dorsal margin of the 10th segment, which undoubtedly has much to do with the retention of the pupa in position at the time of the emergence of the imago. *Laterally*: the dorsal head-piece is conspicuous; the prothoracic spiracle placed deeply in the incision between the pro- and mesothorax, the neuration of the fore-wings conspicuous, the hind-wing prominent beyond the inner margin of the fore-wing; a row of supraspiracular depressions; spiracles on abdominal segments 1 and 2 hidden, on 3-7 black and inconspicuous, although surrounded by fine circular ridges, which form a basin, as it were, around each. The anal segment is much flattened posteriorly. *Ventrally*: The oral area depressed; the maxillæ forming a double ridge, the first two pairs of legs between the maxillæ and antennæ; the tarsi of the second pair of legs hidden beneath the first pair and the antennæ, the tibia only being visible; there is also, as in other Anthrocerid pupæ, a piece between the maxilla and 1st leg, probably belonging to the 1st femur; the glazed eye, smooth and shiny, a broad lunule in shape; the maxillæ extend to the 6th abdominal segment, the third pair of legs to the end of the 5th, the tips being quite free from the abdominal segments. The maxillary palp (or its evanescent base) is a small lateral projection of the maxilla, and is placed beneath the upper end of the first leg. The eye-collar is not the maxillary palp, but the eye-flange, as seen in *Cochlidion* (*Limacodes*). There are two series of ventral depressions, occupying the same position as the larval prolegs. The genital organs on abdominal segment 9 (♂), or 8 (♀), distinct, the anus and cremaster are composed of shiny black chitin, and the terminal segments are turned back dorsally. The front and sides of the first three abdominal segments, though free from the wings and appendages, are pale in colour and delicate in texture.

Dehiscence.—The pupa splits mediodorsally through the prothorax and mesothorax; the cephalothoracic portion being very distinct and attached to the prothorax; the head parts (carrying the glazed eye) go with the maxillæ, whilst the first and second pairs of legs go with the wings, being attached thereto by the fine inner pupal membrane. The movable incisions in the abdomen open out, those between abdominal segments 2-3 and 3-4 to their fullest extent, and show the incisions to be composed of a delicate whitish transparent membrane, whilst the ventral membrane of the abdominal segments themselves, although brownish-black, is also almost transparent. There appears to be considerable difference in the colour of the empty pupal skin, that of some being browner and paler, of others much blacker. It may be that the former are usually female pupæ.

Food-plants.—*Lathyrus pratensis* (Doubleday, Buckler), *Lotus corniculatus* (Buckler), *Trifolium montanum*, *T. rubens*, *Lotus* (Kaltenbach), *Hippocrepis comosa* (Boisduval), *T. repens* (St. John), *Vicia* (Frey).

Parasites.—*Anomalon tenuitarsum*, Gravenh. (Weston) and *Phorocera cilipeda* (Bignell) have been bred from this species.

Habits and habitat.—This species is not very particular as to its habitat, nor does it so completely eschew a marshy district as some authors would have us believe. It abounds in a wood in north Kent, in a rough, grassy ash plantation, spreading thence into the adjacent rides and meadows. At Repton Shrubs it is recorded in mowing grass (Brown), and at Highnam, nr. Gloucester, it flies in wood ridings (Lifton). At Mansfield, it frequents rough, uncultivated ground with a great variety of wild plants (Daws), whilst at Portsdown Hill the locality is dry, although on the salterns near it is found on marshy ground (Forsyth). It is noted as occurring on the canal bank at Cheswardine (Daltry), and at Filey it occurs on rough, grassy cliffs (Maddison). The York locality is in rough, damp fields on the border of Strensall Common, the fields covered with coarse grass, thistles, etc. The insect is also found on the Common itself, and in a lane near it (Hewett). At Flamborough, it occurs within twenty yards of the sea (Boult); near Cheltenham, one locality is situated on a dry railway bank, another among coarse grass, and rough bushy ground on the Cotswolds (Robertson). At the Mullinures, in Armagh, the species abounds in a marsh (Johnson), and Bostock notes it on damp ground, on Cannock Chase, the pupæ attached to rushes; Speyer gives it as haunting a dry, sunny hillside at the foot of the Rigi, whilst Borkhausen records it from the forest near Darmstadt. Doubleday notes it as abounding in moist meadows near Monk's Wood, and Barrett that it occurs in Shropshire, in some rough fields on the top of Wenlock Edge. It abounds on the slopes of the pine woods at the summit of the Mendel Pass, and we have taken it on the slopes below the glacier La Meije, opposite La Grave, in Dauphiné, and on the rocky slopes above Lac Bourget in Savoy. Above Grésy-sur-Aix (near Aix-les-Bains) it occurs in a saintfoin meadow, and at Courmayeur (Piedmont), in a hollow below the pine woods on Mont Courmet, so that its habitats are varied enough. Zeller gives as its habitat at Glogau, open places amongst birch and fir woods, on hillocky ground, where flowers are numerous; Peyerimhoff notes it in the wood clearings, both in the mountains and plains of Alsace, whilst Demaison says that *A. lonicerae* is found in the woods about Rheims, *A. trifolii* being confined to a marshy habitat.

Time of appearance.—The time of appearance varies according to the season, from mid-June in 1893 to late July in 1888. Maddison notes it as appearing usually in July and August at Filey, Porritt in July, 1870, also at Filey, Lowe in August at Dorchester, Raynor in August at Swanage, and Bostock in June, 1887, at the Land's End. On July 16th, 1897, at Filey, freshly-emerged imagines were drying their wings; at the same time, there were numbers of pupæ spun up on the grass-stems, and a few still in the larval stage; the pupæ were very abundant, but confined to a comparatively small area (Maddison). Generally the larvæ have all pupated in the York district by June 15th-20th, and the imagines appear on the wing from the end of the month to the second week in July (S. Walker). The following are actual dates of capture: June 16th, 1860, larvæ only, a late year, at Mansfield (Brameld), June 18th, 1860, at Barnstaple (Mathew), July 11th, 1860, at Maltby Wood, nr. Sheffield (Batty), July 15th-19th, 1860, bred, June 22nd-July 8th, 1884, bred, June 30th-July 3rd, 1886, July 27th-29th, 1887, bred, July 26th, 1888, common, June 22nd-30th, 1889, bred, June 27th-30th, 1890, bred, June 20th, 1891, pupæ, June 17th, 1893, very common, all at Chattenden (Fenn), June 29th, 1866, at Northleach, June 26th, 1897, on the Cotswolds, with *A. filipendulae* (Todd), July 5th, 1875, at Stoke Row (Holland), July 5th, 1880, worn, at Roundstone (J. J. Walker), July 7th, 1881, July 13th, 1885, July 19th, 1891, July 24th, 1892, June 30th, 1893, July 8th-15th, 1895, July 6th-7th, 1896, July 10th, 1897, at Strensall Common (Hewett), July 4th, 1882, June 26th, 1885, June 22nd, 1886, July 16th, 1887, July 16th, 1889, July 12th, 1890, July 10th, 1891, June 24th, 1892, June 9th, 1893, June 26th, 1894, at Mansfield (Daws), June 30th, 1886, July 20th, 1888, worn, at Favour Royal (Kane), July 11th, 1887, at Flamborough Head (Boult), July 16th, 1887, worn, at Chattenden (Mera), June 3rd, 1887, July 14th-16th, 1888, just out, June 20th, 1896, at Chattenden (Tutt), June 20th, 1889, at Hartley Wintney, June 23rd, 1895, June 11th, 1896, July 2nd, 1897, nr. Cheltenham (Robertson), July 16th, 1891, June 23rd, 1892, at Chattenden (Bristowe), July 31st-August 1st, 1891, at Swanage (Raynor), July 2nd-22nd, 1892, June 30th-July 20th, 1893, June 27th-July 18th, 1896, July 7th-July 27th, 1898, at Wyre Forest (Abbott), June 9th, 1893, at the Mullinures (Johnson), August 3rd, 1894, nr. Dorchester, in fresh condition (Lowe), June 20th-July 3rd, 1896, at Chattenden (James), June 27th, 1896, first imago bred from Sandburn (Ash), June 30th, 1896, at Chattenden (Prout), July 4th, 1896, at Chattenden (Page), June 29th-July 6th, 1897, June 15th-July 4th, 1898, at Tullylagan (Greer), July 18th, 1856, on the south side of the Rigi (Speyer), July 24th-August 15th, 1887, in Silesia (Teicher), August 1st-5th, 1894, singly, at Courmayeur, July 28th-August 3rd, 1895, at Mendel Pass, abundant and fresh, July 25th-26th, 1896, abundant, July 22nd-26th, 1897, rare, July 22nd-28th, 1898, common, above Grésy-sur-Aix (Tutt), July 6th, 1886, in the Valais (Blachier), July 3rd, 1892, at San Stefano (Knecht), June 26th, 1898, at Auswinkel, nr. Buda-Pest (Burr), July 28th, 1898, between the Bashkaus and Tchulyshman rivers (Elwes). Some observations we made on this species (also on *A. filipendulae* and *A. carniolica*) at Grésy-sur-Aix, lead us to suppose that a very large percentage of larvæ, in a cold spring, hybernate a second year, and that only in certain seasons suitable to the species does the greater number of larvæ feed up and emerge after the first winter.

Localities.—Argyll: Oban (Barrett). Armagh: The Mullinures (Johnson). Beds: (Barrett). Cheshire: Knutsford (Harrison). Cornwall: nr. Land's End, common (Bostock). Cumberland: Keswick (Greenip). Derby: Burton-on-Trent (Stainton), Derby (Pullen), Repton Shrubs (Brown). Devon: Exeter and Teignmouth (Stainton), Barnstaple (Mathew). Dorset: nr. Dorchester (Lowe), Blandford (Stainton), Swanage (Raynor). Durham: Gibside (Robson). Essex: Saffron Walden (Norgate). Fermanagh: Belleisle (Kane), Enniskillen (Partridge). Galway: Roundstone (J. J. Walker). Gloucester: Highnam (Lifton), Stroud and Clifton (Griffiths), Northleach, Cotswolds (Todd), nr. Cheltenham (Robertson), Bristol (Stainton). Hants: Ampfield (Hewett), Winchester (Stainton), Hartley Wintney (Robertson), Portsdown Hill and Salterns nr. Portsmouth (Forsyth). Hereford: Leominster (Hutchinson), Tarrington (Wood). Hunts: Monk's Wood and Holme Fen (Doubleday). Kent: nr. Strood (Bower). Kerry: Ballinskelligs Bay (Kane). Lincoln: Grantham (?) (Goulding). Middlesex: Stanmore Common (L. Newman). Monaghan: nr. Favour Royal (Kane). Norfolk: (Barrett). Northampton: Helpston Hill, nr. Peterborough (Morley). Northumberland: Shull (Backhouse), Tynemouth (Robson). Notts: Mansfield (Daws). Oxford: Stoke Row (Holland). Shropshire: Wenlock Edge (Barrett). Somerset: Clevedon (Mason), Weston-super-Mare (Crotch). Stafford: Cheswardine (Daltry), Cannock Chase (Bostock), Suffolk: Tuddenham (Jenner), Foxhall Heath (Miller), Beccles (Crowfoot). Surrey: Dorking, Ranmore Common (Baldwin), Camberlay (Watson), Croydon (Briggs *teste* Barrett). Sussex: Brighton (Stainton), Hayward's Heath and Cuckmere district (Jenner), Poynings Common (Image). Tyrone: Tullylagan (Greer). Wales (South): (Hudd). Warwick: Farnboro' (Lifton), Coventry (Nicholls). Worcester: Malvern (Todd), Bockleton (Decie), Worcester (Smith). Yorks: Askham (Prest), Barnsley (Harrison), Boston Spa and Filey (Porritt), nr. York (Walker), Bridlington (Boult), Pontefract (Hartley), Royston (Taylor), Sandburn Common (Ash), Scarborough (Wilkinson), Maltby Wood (Batty), Sheffield (Doncaster), Strensall Common (Hewett), Thomparch (Wilson), Flamborough (Boult), Horsforth (Mansbridge).

Distribution.—Asia: Armenia, Pontus (Staudinger), Amasia, nr. Tokat (Speyer), Obi and Yenesei districts (Erschoff), Amurland (Brit. Mus. Coll. *teste* Tutt), between the Bashkaus and Tchulyshman rivers, at about 5,000 ft. (Elwes). Austria: Cracow (Zebrawski), Auswinkel, nr. Buda-Pest (Burr), Brünn, Hochwald, Innsbruck, Kessen, Prague, Rosenau, Rottalowitz, Salzburg, Vienna (Fritsch), Buda (Speyer), Cortina, Mendel Pass, abundant (Tutt), Bucovina, generally distributed, also on mountains, (Hormuzaki), Galicia, widely distributed (Garbowski). Belgium (Speyer). Bulgaria: nr. Sofia, Kokaleny-Kloster (Bachmetjew). Denmark: common (Reuter), Seeland (Boie). France: generally in northern and southern (Lucas), also eastern and western France

(Berce), Cevennes (Bellier), nr. Paris, Larche, Cauterets, very common (Oberthür), nr. Gavarnie, Digne (Pierret), Depts. Meuse, Moselle, Puy-de-Dôme (Speyer), Nohant, Sologne, Bourges, Guéret, plaines de la Limagne (Sand), Aix-les-Bains, Dauphiné Alps, La Grave, Aube, St. Michel de Maurienne (Tutt), Forest of Sénart, Depts. of Doubs, Saone-et-Loire, Auvergne, Normandy (Berce), nr. Rheims, common, Rilly, Germaine, Gueux, Courcy (Demaison), nr. St. Quentin, Calvados (Dubus), Dept. du Nord (Dupont), Loire Inférieure (Bonjour). Germany: generally distributed (Heinemann), Julow, nr. Stettin (Hering), Soultzmatt, Kastenwald, Trois-Épis, Nonnenbruch, Hardt, Basle, Dorneck (Peyerimhoff), Silesia (Assmann), Glogau (Zeller), Siebenbürgen (Speyer), Pfalz, Würtemberg, Nassau (Reutti), Gotha, etc. (Knapp), Leubusch (Prittwitz). Greece: Parnassus, Veluchi (Krüper *teste* Staudinger). Italy: not rare in north, central and southern Italy (Curò), Naples (Costa), Courmayeur (Tutt). Roumania: Kloster Neamtz, Grumazesti, Pleschburg, Slanic, Azuga, etc. (Caradja), Tultscha (Mann), Turn Severin (Haberhauer). Russia: Kokenhusen, Riga, Schleck, Mitau, Pichtendahl, Lechts, Tois (Nolcken), Finland to 62° N. lat. (Reuter), St. Petersburg, Livonia, Volga dist. (Speyer), Kasan, Orenburg, nr. Sergievsk, Busuluc (Eversmann), north Russia from the White Sea to the Urals, Moscow dist., Poland, from mouths of Danube to Dnieper, Transcaucasia (Erschoff). Scandinavia: common everywhere up to 60° 30′ (Aurivillius), Wermdön (Meves), Christiania, Dovre, Sunddal (Siebke), Blekinge, Gothland (Dahlbom), West Gothland (Gadamer), East Gothland Småland (Boheman). Spain: Granada (Rosenhauer). Switzerland: Generally distributed (Frey), Grisons, Pensch, Bergün (Zeller), Simplon (Rätzer), Engadine Valleys (Mengelbir), Schaffhausen (Trapp), nr. Winterthür (Biedermann), nr. Zürich (Frey), Rigi (Huguenin), Bremgarten (Boll), Lenzburg and Jura slopes, Lucerne, Wäggis, nr. Thun, Chexbres, Vevey (Wullschlegel), Bechburg, Valais (Riggenbach), Bern (Meisner), Gadmenthale (Rätzer), Schüpfen (Rothenbach), Tessin, Chiasso (Knecht).

ANTHROCERA TRIFOLII, Esp., and A. PALUSTRIS, Oberth.

There are two forms or subspecies occurring in Britain under the name of *A. trifolii*, one, a comparatively small insect, measuring from 23-33 mm. in wing-expanse, appearing usually in late May and June, the other, a much larger insect, averaging 29-38 mm. in expanse, appearing generally in July and early August, although these dates are, of course, subject to considerable variation according to the season. Briggs first separated these forms, calling them the "early" and "late" *trifolii* respectively. The former is, in Britain, especially partial to pastures and meadows, the latter to marshy ground (often near the sea). Each shows an exactly similar range of variation in the spotting, extending from individuals with five separate spots, through every intermediate condition, until the whole of the spots form a strongly-defined longitudinal streak, occupying the greater portion of the wing. These races we have recently separated (*Entom. Record*, ix., p. 88) as *trifolii-minor* and *trifolii-major* respectively, but there is no doubt that Oberthür's *palustris* is the prior name for the latter form. Another important fact is that the early *A. trifolii* is frequently taken in the same meadows as *A. hippocrepidis*, Stephs., the latter being passed over as early *A. filipendulae*, although we have already hinted (*Ent. Rec.*, ix., p. 88) that *hippocrepidis*, Stephs., is probably a modified form of *A. trifolii*. Briggs notes that the larva of *A. palustris* (*trifolii-major*) approaches more nearly to that of *A. filipendulae*, and differs considerably from that of *A. trifolii*.

Oberthür recognises three forms of *A. trifolii* in France: (1) The southern or mountain form—very small, less bright in colour, the red tinged with violet, less opaque, and slightly transparent, the blue border of the hind-wings rather wider. Flies at the commencement of June, at Auch (Gers), Banyuls, Le Canet, Vernet-les-Bains and Uriage. [Oberthür believes that it is this form that Duponchel figures (*Hist. Nat.*, supp. ii., pl. viii., fig. 1). He himself figures it in the *Etudes*, etc., xxth livr., pl. viii., fig. 150.] (2) The central form—brighter in colour, the red of a purer carmine, the spots of the fore-wings larger than in 1. Flies in July and the commencement of August at Biarritz, Cancale, Îles Chausey near Granville, Limoges, Dept. de la Sarthe and Normandy, usually near the sea. [Oberthür believes this to be the form figured by Duponchel (*Hist. Nat.*, supp. ii., pl. vi., fig. 7)]. (3) The Rennes form (*palustris*)—larger, more brightly coloured, the spots frequently confluent, emerging in May and early June at Rennes, in late June at the Forêt de Lorges and Quiberon. [This Oberthür considers to be represented by Boisduval (*Icones*, pl. liv., fig. 8)]. He figures it himself in the *Etudes*, etc. (xxth livr., pl. viii., figs. 151, 152, 153), but informs us that the colour is not bright enough. Oberthür refers most of the British examples in his collection (50 altogether) to the form 2, but specimens from Tugwell's collection, labelled "Freshwater, vii., '72," have the colour and size of *palustris*, whilst specimens labelled "Hailsham, vi., '92," appear to be transitions between the forms 1 and 2. Oberthür further adds that there are in the Dept. Ille-et-Vilaine, two forms of *A. trifolii*, (1) emerging in May and June in fields near woods, nr. Rennes, (2) emerging in July and commencement of August on the marshes by the seaside at Cancale, and in the Îles Chausey, between Granville and Cancale.

It is somewhat remarkable that our experience in Britain coincides only in part with that in France. Our "early" form agrees in its small size and the early date of its appearance with Oberthür's form 1. Our "late" form agrees generally with Oberthür's form 2; but our "late" form includes the extreme large form *palustris*, as represented by the Freshwater specimens (*teste* Oberthür), whereas, in France, this same *palustris*, appears in May and June in fields near woods, and although Oberthür writes that Boisduval had distinguished in his collection a form of *trifolii* as *palustris*, which name he has maintained, yet Oberthür's specimens, whilst agreeing in every particular in size and colour, can hardly be termed a "marsh" race. He goes on to say that, unfortunately, Boisduval had "not distinguished by a label the particular specimen figured in the *Icones*." There are, he adds, some specimens of *palustris*, found in France, extremely similar to his form 2, but the greater part of the *palustris*, which emerge in May and June, at Rennes, appear to belong to a very specialised local race. This evidence would suggest that Boisduval's *palustris*, MS., is our late "marsh" form, and that Oberthür has, at Rennes, an insect with all the characters of our larger and later form, but appearing in May and June, and not occurring on marshes.

Speyer's evidence tends to show (*Stett. Ent. Zeit.*, xxxviii., pp. 40 *et seq.*) that the July *A. trifolii*, in north-western Germany, inhabits marshes, and also suggests that the marsh insect emerges over a long period of time, and that a little specially advantageous or disadvantageous environment might readily make it an early or late insect, *i.e.*, that local considerations determine whether the insect in a given place shall be of the early or late form. Speyer captured two specimens of ab. *trivittata* on July 7th and 10th respectively. He further says that in his district the insect generally commences to emerge about the middle of June, the period of emergence lasting from four to six weeks. In a late year, 1876, he states that the first imago did not put in an appearance until June 28th, larvæ being found as late as June 21st. One could have wished that Speyer had given some exact dates as to the relative appearance of the "large" and "small" forms of *A. trifolii*, and a detailed difference as to their habitat, for that both forms occur, and are well known in Germany, is certain from his remark that a specimen of ab. *trivittata*, described by him, "belongs to the small-winged form of this, in other ways very variable, species, and is somewhat under the average size."

Even in Britain there is no sharp line of demarcation in the time of appearance (nor in the size) of what we have termed *trifolii-minor* and *palustris* (*trifolii-major*), for, in some places, the small race is regularly later in its time of appearance than in others, *e.g.*, the small form found in the New Forest is regularly later than that in Kent (Canterbury, Strood, etc.). Fletcher (including both forms in his generalisation) says that there seems to be a constant succession of specimens from different colonies from May until the beginning of August. At Emsworth on the downs, and about Abbott's Wood in wet meadows on the clay, it is out early in June; in the New Forest it flies early in July, at the same time as *A. viciae* (*meliloti*). Fletcher found a colony in a heath bog not far from Worthing, fully out on June 30th and July 1st, 1897, and bred specimens from a score of pupæ up to July 18th. These last dates reach up to the appearances that have been recorded for July and August. Oberthür remarks also on the variation of the time of appearance of this species, and connects it with the various races (*vide*, p. 481). He observes that in July, 1895, *A. trifolii* was still fresh at Biarritz more than a month after it had gone over at Uriage and at Rennes. In August, 1883, in the Isles of Chausey, in front of Granville (Manche), *A. trifolii* was still flying, two months later than the appearance of the same species in Ille-et-Vilaine. As bearing on this point, we suspect that the difference in the time of appearance is due to a tendency for this insect to become a two-year or one-year species, in some localities, according to its environment, and the evidence seems to suggest, not only in this species, but also in *A. filipendulae*, that a marshy habitat tends to a later appearance, yet it is marvellous that some of the mildest parts of the British Islands—Freshwater, Swanage, etc.—produce the latest broods. Usually, the latest broods (presumably the larvæ having taken longer to feed) are the larger, but the Rennes form, as large as our largest British form, appears in May and June, whilst smaller insects occur in August, on that part of the French coast nearest the Channel Islands. On these islands, too, there are two races, an early form occurring in June, on the Guernsey cliffs and in Sark, and a later one in late July and August, in Herm. There are two explanations as to the cause of this constant difference in the time of appearance, as exhibited by different colonies of this species, that may be possibly correct, (1) that the greater number of marsh *A. trifolii* and *A. filipendulae* take two years to complete their metamorphoses, owing probably to the lower average temperature of such districts, (2) that they have developed a habit of feeding (and pupating) later, and so have shortened the period of hybernation, and thus, having a longer feeding larval period, attain a greater size, even if they only take one year. The fact that Fletcher has been able (*ante*, p. 418) to obtain occasional second-brooded specimens of the small down and meadow form of *A. trifolii*, supports the view that this early race tends to feed up more rapidly.

So far as the evidence leaves one any room for generalisation, there appears every reason to conclude that we have, in Britain and France, at least, two fairly well-defined and specialised subspecies, and as such we propose to deal with them, trusting that these remarks will be the means of drawing attention to an interesting phenomenon, and will lead to exact observations being published of the various forms of the species existing in different parts of its geographical area.

ANTHROCERA TRIFOLII, Esper.

SYNONYMY.—Species : *Trifolii*, Esp., “Die Schmett.,” ii., p. 223, pl. xxxiv., figs. 4-5 (1783) ; Bork., “Sys. Besch.,” ii., pp. 26, 123, 164 (1789) ; “Rhein. Mag.,” i., pp. 305, 635 (1793) ; De Vill., “Ent. Linn.,” ii., no. 54, p. 113 (1789) ; Hb., “Eur. Schmett.,” fig. 79 (? 1803), p. 80 (? 1805), figs. 133, 134, 135 (? 1818) ; “Verz.,” p. 117 (? 1822) ; Ochs., “Die Schmett.,” ii., p. 47 (1808) ; Stephs., “Illus.,” i., p. 108 (1828) ; Bdv., “Mon. Zyg.,” p. 54, pl. iii., fig. 7 (1829) ; “Icones,” p. 59, pl. liv., fig. 8 (1834) ; Dup., “Hist. Nat.,” supp. ii., pl. vi., fig. 7 ; pl. viii., fig. 1 (1835) ; Selys, “Cat. Lép. Belg.,” p. 23 (1837) ; “Mém. Soc. Sci. Liége,” ii., p. 33 (1845) ; “Ann. Soc. Ent. Belg.,” 1872, pp. lvii-lix ; Ibid., 1882, p. cxiii ; Wood, “Ind. Ent.,” p. 11 (1839) ; Evers., “Lep. Faun. Volg.-Ural.,” p. 96 (1844) ; H.-Sch., “Sys. Bearb.,” p. 37 (1845) ; Assmn., “Abbild. Besch. Schmett. Schles.,” ii., p. 10 (1845) ; Kayser, “Schmett. Deutsch.,” p. 168 (1852-9) ; Sta., “Man.,” i., p. 80 (1857) ; Ramb., “Cat. Lép. And.,” p. 177, pl. i., figs. 5-8 (1858) ; Speyer, “Geog. Verb. Schmett.,” p. 346 (1858) ; “Stett. Ent. Zeit.,” xxxviii., pp. 40-51 (1877) ; Wallgrn., “Skand. Het.-Fjär.,” p. 105 (1863) ; Lucas, “Hist. Nat.,” p. 155 (1864) ; Snellen, “De Vlinders,” p. 127 (1867) ; Newm., “Brit. Moths,” p. 23 (1869) ; Staud., “Cat.,” p. 47 (1871) ; Briggs, “Trans. Ent. Soc. Lond.,” pp. 422 *et seq.* (1871) ; “Proc. Ent. Soc. Lond.,” pp. xiv-xv (1875) ; Curò, “Bull. Soc. Ent. Ital.,” vii., p. 197 (1875) ; Kirby, “Eur. Butts.,” etc., p. 90 (1879) ; “Cat. Lep. Het.,” p. 68 (1892) ; “Handbook,” etc., p. 90 (1895) ; Sand, “Cat. Lép. Auv.,” p. 27 (1879) ; Frey, “Lep. der Schweiz,” p. 67 (1880) ; “Mitt. Sch. Ent. Gesell.,” vii., p. 15 (1887) ; Girard, “Bull. Ent. Soc. Fr.,” (5), x., p. cxv (1880) ; Peyer., “Cat. Lép. Als.,” p. 47 (1880) ; Oberth., “Lép. des Pyr.,” p. 30 (1884) ; “Var. chez Lép.,” pp. 43-5, pl. viii., fig. 150 (1896) ; Hofmn., “Die Gross-Schmett.,” p. 35 (1887) ; “Die Raupen,” etc., p. 36 (1893) ; Buckler, “Larvæ,” etc., ii., pp. 94-97, pl. xix., fig. 2 (1887) ; Auriv., “Nord. Fjär.,” p. 53 (1888) ; Higgs, “Ent. Rec.,” i., p. 12 (1890) ; Parry, “Ent. Rec.,” ii., p. 108 (1891) ; Tutt, “Ent. Rec.,” ii., p. 109 (1891) ; “Brit. Moths,” p. 353 (1896) ; “Ent. Rec.,” ix., p. 88 (1897) ; Webb, “Ent. Rec.,” ii., p. 199 (1891) ; South, “Entom.,” xxvi., p. 215 (1893) ; Barr., “Lep. Brit.,” ii., p. 127, pl. lix., figs. 1*a-c* (1894) ; Christy, “Entom.,” xxviii., p. 214 (1895) ; Meyr., “Handbook,” etc., p. 448 (1895) ; Caradja, “Iris,” viii., p. 72 (in part) (1895) ; Reutti, “Lep. Bad.,” 2nd Ed., p. 44 (1898). *? Pratorum*, De Vill., “Ent. Linn.,” ii., p. 114 (1789). *Loti*, Godart, “Hist. Nat.,” iii., p. 134 (in part), pl. xxii., fig. 4 (1821) ; Wood, “Ind. Ent.,” fig. 4 (1839).

ORIGINAL DESCRIPTION.—Alis superioribus virescenti-cyaneis, maculis tribus rubris longitudinaliter digestis, coadunatis. Diese Gattung der rothfleckigten Sphinxe hat sich erst neuerlich in der Gegend von Frankfurt am Main entdeckt. Anfangs fand sich nur ein einzelnes Exemplar, das man für eine seltene Ausart gehalten. Bei emsigen Nachsuchen kamen mehrere zu Handen, man hat sie endlich auch in Paarungen angetroffen. Vorliegende Abbildungen legen sie nach beiden Geschlechtern vor Augen. Den sorgfältigen Beobachtungen des Herrn Gerning haben es meine Leser zu danken, dass diese Entdeckungen nicht länger verborgen geblieben. Es sind mir verschiedene Exemplare davon zur Vergleichung mitgetheilt worden. Nach der Grösse des ganzen Körpers und dem Schnitt der Flügel, ist nichts verändertes von jenem mit dem *Sphinx filipendulae* hierinnen übereinstimmenden Arten, zu sehen. Lediglich die Zeichnung der Oberflügel machen den wesentlichen Unterscheid aus. Man wird hier nur drei einzelner gerundeter Flecken, die Länge hin geordnet, gewahr. Der mittlere ist der grösste, der an der Grundfläche aber kleiner. Er ist von der sich durchziehenden Sehne kaum merklich getheilt. Ihre Farbe fällt ins Mengrothe, sie ist sonach weniger als an erstbeschriebenen Arten erhöht. An dem Weibchen sind diese Flecken durch Zwischenräume der Grundfarbe getrennt. Diese Abweichung ist in der That sehr auffalend. Ich habe von dem gemeinen Wiesenklee, dem gewohnlichen Gelage dieser sämmtlichen Gattungen den Namen entlehnt (Esper, *Die Schmett. in Abbildungen*, etc., p. 223). [Esper figures several forms of this variable species. On pl. xxxiv., fig. 4, is the confluent form, ab. *minoides*, Sélys, and fig. 5 is the form with 1 + 2, 3 + 4, and 5, forming three spots. Since this is described in the text, we have taken the description and fig. 5 to represent the type-form of the species.]

Imago.—Anterior wings 23-33 mm.; greenish or purplish, with five crimson spots, usually more or less confluent. Posterior wings crimson, with a broad purplish-black hind margin.

Sexual dimorphism.—The females are distinctly larger than the males, the latter extending from 23 mm.-32 mm., the former from 29 mm.-33 mm. in the smaller form, whilst in the *palustris* from Rennes, the males run from 33 mm.-37 mm., the females 36 mm.-39 mm., although many of our British *palustris* males do not exceed 29 mm., nor the females 33 mm. The females are, as a rule, much more liable to run into blotched aberrations than the males. The males are distinctly of three shades of colour, (1) a distinct bluish-purple = ab. *caerulea*, n. ab., a rare form, (2) a deep blue-green form = the type, (3) a bright bronzy-green, a very rare form = ab. *orichalcea*, n. ab. The females are rarely, if ever, of the purple form, and are usually of the bright bronzy-green form, although the deep blue-green type form is not at all rare. The extreme purple specimens are almost always males, the extreme bronzy-green specimens, females. The antennæ are, as a rule, finer in the females than in the males.

Comparison of A. trifolii with A. palustris (trifolii-major) and A. loniceræ.—Expanse of fore-wings averaging 23 mm.-33 mm., those of *A. palustris* (British) 29 mm.-38 mm., (from Rennes) 33 mm.-39 mm. Antennæ almost as stout in former as latter; the head much more densely clothed with hairs; the fore-wings usually of a darker green, and the spots and hind-wings sometimes quite crimson; the marginal border to hind-wings much broader, especially in ♂, and rather uniform in width (Briggs). We are unable to detect any marked difference in the colour of the red in the two forms, but there is distinctly less variation of the ground colour in *A. palustris* than in *A. trifolii*. In the former there is also a more marked sexual dimorphism, the ♂ being dark blue-green, the ♀ of a bright bronzy-green, the forms rarely overlapping in the sexes. We should agree that there is a distinct tendency for the males of *A. trifolii* to have a broader hind-marginal band to the hind-wings than we find in those of *A. palustris*. We have an otherwise typical female of the latter from Upton St. Leonards, in which the marginal band is reduced to a slender marginal line. In Britain, *A. trifolii*-(*minor*) is generally less than *A. lonicerae*, the latter being, on an average, rather above the size of *A. palustris*. Boisduval says that the French *A. trifolii* (probably the southern form) is a quarter less than *A. lonicerae*, to which the species is very similar, but with less lanceolate (more rounded at apex) fore-wings. He remarks also on the central pair of spots being almost always united. He further notes that near the apical spot, at its side, there is sometimes a small red point. Duponchel simply repeats the same characters.

Variation.—The races of this species have been already dealt with and incidentally the variation in size to which it is subject. In its spotting it is one of the most variable of the Anthrocerids, and confluent forms are more common in this than any other of the "spotted" species. We have already noticed that this confluence takes place usually by 1 + 2, 3 + 4 and 5, forming three spots, and then by 1 + 2 being joined to 3 + 4, and 3 + 4 to 5, by longitudinal streaks. This must be looked upon as the normal line of development. A rarer form of blotching consists of 1, 2 + 4 and 3 + 5. In Britain, France and Germany, the extremes of blotching are, on the one hand, the distinctly five-spotted form, on the other hand, the ab. *minoides*, Sélys, or its extreme form, as figured by Christy, in which the whole of the area, except a narrow inner and outer marginal edge, has become red = ab. *extrema*, n. ab. The other aberrations all fall between these two extremes, and form a continuous link (with the exception of the rare ab. *trivittata*, Speyer). Even in the ab. *trivittata*, however, Speyer says that there is a tendency for red scales to be developed on the otherwise dark dividing nervures. It remains, however, a remarkable fact that we have the two most divergent types of Anthrocerid markings in the blotched forms of this species. Of 100 specimens, taken at random in one district, Speyer found 20 per cent. = ab. *orobi* (5 spots distinct, or 1 + 2, 3, 4, 5), 60 per cent. = *trifolii* (with 3 spots), 10 per cent. = ab. *basalis* + ab. *glycirrhizae* (1 + 2 + 3 + 4, 5, and 1 + 2, 3 + 4 + 5), 5 per cent. = ab. *minoides* (all spots united), 5 per cent. being unclassified. Occasionally one or more of the spots is absent = ab. *obsoleta*, n. ab. Such a specimen (with 4 absent) is figured by Christy (*Entom.*, xxix., p. 341). We have one example, taken at Upton St. Leonards in 1888, with 3 on the left fore-wing absent on the upper, but present as a small point on the under, side. In colour, too, there is considerable variation, yellow, and intermediate (orange-red) aberrations being perhaps more frequently met with in this than any other British species. A specimen with orange spots and orange hind-wings is noted (*Ent. Record*, vi., p. 135), and we have several that might be termed dull orange-red in colour. South notices a specimen of the ab. *orobi*, taken in Middlesex, in which spot 4 on (? both) the fore-wings is yellowish-red, all the other spots being normal in colour, and Bond-Smith notes a specimen from Gamlingay, in July, 1891, as having the basal spot on the left fore-wing yellow, all the rest being typical. In 1893, Christy obtained from Emsworth, among many yellow specimens, several that were more or less incomplete in structure and colour, and he further informs us that similar malformed specimens continue to occur year by year, some without any wings and others with curiously cropped ones. Oberthür remarks that, in his experience, the blotching of *A. trifolii* has a tendency to commence from the outer spots as frequently as from the basal ones, whilst in *A. filipendulae* the blotching usually commences at the base and extends thence towards the tip. Frey considers that in Switzerland and Germany, *A. trifolii* is one of the most variable species; its antennæ, he says, show transitions to the *lonicerae* form, and he instances var. *gracilis*, Fuchs, in support of this statement. Rambur's figures (*Cat. Lép. And.*, pl. i., figs 5-8) of the Spanish *A. trifolii* are hardly recognisable, but he states that the Andalusian examples appear to be near *stoechadis*, although united so completely with specimens of *A. trifolii* that they cannot be separated therefrom, they also come very near the var. *syracusia*. He further states that he finds no specific difference between the Spanish examples and those from Paris, Touraine, Périgueux, Tarbes, Marseilles and Perpignan. He has also reared larvæ from Touraine, Perpignan and Malaga, and finds no difference. Snellen notes the type form (in Holland) as having the basal spots elongate, the others round, the upper of the middle pair small, the hind-wings with a broad, blue-black margin. He says the species varies much in the form and size of the spots, and considers that most of the aberrations fall into one of two forms: (1) With the upper spots of the basal and central pairs united with the under. (2) The spots above all united into one longitudinal stripe. His measurements (30-36 mm.) suggest that the Dutch *A. trifolii* belongs to the *palustris* form. The width of the marginal band of the hind-wings is also very variable; in some examples it is not much wider than in normal *A. lonicerae*, in others, it forms a band extending almost to half the width of the wing, the inner marginal nervure and the median nervure being also, sometimes, distinctly tinged with black. Prout observes that, at Broxbourne, examples occur with very small red spots on the fore-wings, and with the hind-marginal band of the hind-wings much broadened.

a. ab. *orobi*, Hb., "Eur. Schmett.," ii., fig. 133 (without description), (? 1818); Staud., "Cat.," p. 47 (1871); Sélys, "Ann. Soc. Ent. Belg.," 1872, p. lviii; Ibid., 1882, p. cxiii; Sand, "Cat. Lép. Auv.," p. 23 (1879); Frey, "Lep. der Schweiz," p. 67 (1880).— ♀. Expanse of wing 28 mm.; anterior wings dark purplish in colour, with the 5 normal red spots separate from each other; hind-wings normal.

This form has the five red spots of the anterior wings separate from each other. [In some copies of Hübner's work (*e.g.*, that at the Natural History Museum, South Kensington), a sixth supplementary spot is figured between 3 and 5.] It appears to be very generally distributed, although rather less common in many places than the type (1 + 2, 3 + 4, 5). On the other hand, in Guernsey, it is the most common form; and it may be well to remark here that, though very many of the *A. trifolii* captured there might be referred to the small form, the ♀ s occasionally reach from 30-35 mm. It appears to us that var. *syracusia* is simply this form developed into a local race.

The ab. *orobi* occurs generally in Belgium, England, France, and Germany with the type. In Switzerland, according to Frey, it is rare. He only gives Trafoi (Wocke) as a locality.

β. ab. *obscura*, n. ab.—A specimen from England (coll. Battershell-Gill) with the spots and inferior wings brown, but with a tint a little paler than *A. filipendulae* ab. *chrysanthemi* and *A. hippocrepidis* ab. *nigricans*. In coll. Oberthür [Oberthür, *Var. chez Lép.*, pp. 43-44 (1896)].

Webb records (*Ent. Rec.*, i., p. 33) a specimen of this form as being in the Robertson collection, Liverpool, also a second doubtful one in Mason's collection, Burton-on-Trent.

γ. ab. *semilutescens*, Higgs, "Ent. Record," i., p. 12.—Base of hind-wings orange.

δ. ab. *intermedia*, n. ab.—With the spots of the fore-wings and the hind-wings of a dull orange colour tinged with reddish (not deep crimson, like the type). An occasional subform of *intermedia* has the spots of the fore-wings normal, but the under-wings orange-red, as in the latter form.

We do not feel at liberty to extend the unsatisfactory diagnosis of Higgs' *semilutescens*, otherwise it should, perhaps, be united with this form. Bond-Smith records specimens of *intermedia*, from Gamlingay, July, 1891. Christy notes it as rare at Emsworth; he further notes that, from a batch of eggs laid by an intermediate ♀ in 1895, he bred 200 examples, all typical red ones. In our own series are specimens from Wye, New Forest, etc. The red tinge, in some examples, is reduced to a minimum, and, in one individual from Wye, the left side has a blue-tinged fore-wing, with orange-red hind-wing, whilst the right side has a green fore-wing and crimson hind-wing; the left side shows a distinct failure of development, suggesting that the blue ground colour to the fore-wing, and the orange-red hind-wing, are both less specialised conditions than the green and crimson. South notes specimens with the hind-wings and spots on fore-wings, orange-red, taken in Middlesex in 1893, and Bristowe exhibited, at the meeting of the South London Entomological Society, October 27th, 1892, specimens intermediate in colour between the red and yellow forms.

ε. ab. *lutescens*, Ckll., "Entom.," xx., p. 152 (1887); Tutt, "Young Nat.," ix., p. 152 (1888); Higgs, "Ent. Rec.," i., p. 12 (1890).—Anterior wings with the ground colour normal, but with the usual red spots and the hind-wings of a clear yellow colour.

Cockerell, in naming this aberration, simply gives the reference "*Entom.*, 1878, p. 102." Turning to this, we read that Wellman "exhibited some yellow forms of *Zygaena trifolii*, reared from larvæ." Bond-Smith describes certain Gamlingay specimens (probably *palustris*), caught July 16th, 1891, and bred later, as being of a "beautiful lemon-yellow, showing no trace whatever of red." This aberration has been recorded from Malpas, in Cheshire (Walker), Emsworth, where 100 were obtained in May, 1893, and 11 in 1894 (Christy), Upton St. Leonards (Higgs), Chattenden (Tutt).

ζ. ab. *basalis*, Sélys, "Ann. Soc. Ent. Belg.," 1872, p. lix; Ibid., 1882, p. cxiii. *Trifolii*, Hb., "Eur. Schmett.," fig. 134 (?1818).—The two median spots united, and confluent with the basal only, the apical spot being separate; this last aberration is less common than the others (*minoides*, *glycirrhizae*, etc.).

Generally distributed with the type and other common aberrations in Belgium, Britain, France, Germany, etc.

η. ab. *glycirrhizae*, Hb., "Samm. Eur.," ii., fig. 138 (? 1818). *Glycirrhiza*, Freyer, "Neu. Beit.," p. 116, pl. 164, fig. 3 (1836); Sélys, "Ann. Soc. Ent. Belg.," 1872, p. lviii; Ibid., 1882, p. cxiii.—The original figure represents a ♀ of the large form. Anterior wings with the two basal spots united into one blotch, and 3 + 4 + 5 into another; the spots of a dull reddish colour. The hind-wings normal, except that the crimson is inclined to orange at the base.

This form is generally distributed in Belgium, Britain, France, Germany, etc., and is more frequently of the normal red colour than of the tint figured by Hübner.

θ. ab. *minoides*, Sélys, "Cat. Lep. Belg.," p. 23 (1837); "Mém. Soc. Sci. Liége," ii., p. 33 (1845); "Ann. Soc. Ent. Belg.," 1872, p. lvii; Ibid., 1882, p. cxiii. *Trifolii*, Esp., "Die Schmett.," xxxiv., fig. 4 (1783). *Confluens*, Staud., "Cat.," p. 47 (1871); Sand, "Cat. Lép. Auv.," p. 22 (1879); Higgs, "Ent. Rec.," i., p. 12 (1890). *Orobi*, Berce, "Faun. Ent. Fr.," ii., p. 74 (1868).—Maculis confluentibus. In this aberration the five red spots of the fore-wings are united so as to form one longitudinal band, as in *Z. minos*, but of different form. The hind-wings are, on the other hand, margined with black, as in the ordinary specimens.

This form was re-named *confluens* by Staudinger, and diagnosed (*Cat.*, p. 47) as, "Mac. omnibus confluentibus." The oldest figure of the form is Esper's pl. xxxiv., fig. 4, a blue-green ♂, with 1 + 2 + 3 + 4 + 5 united, which ought, perhaps, to be considered as the real type of the species. Boisduval notes this aberration as occurring with the type in central and southern Europe. It is found almost everywhere with the type, in Belgium, England and Wales, France, Germany, etc., and occurs in Switzerland, nr. Zürich. It appears to be decidedly rarer in the small, early form, than in the later and larger one, and also to be much rarer in the southern forms of the species from Italy, Spain, etc. Homeyer notes that, in 1880, he obtained some hundreds of cocoons in the Wiese district, from which many imagines emerged, several being *confluens*; in 1881 there were none. The confluent form is very rare in Guernsey, only four or five examples out of a very great number examined having been observed (Lowe); it occurs pretty frequently, however, on the cliffs nr. Dieppe with the type (Dupont).

ι. ab. *lutescens-confluens*, n. ab.—The spots on the fore-wings united into a single band; the band and the hind-wings yellow in colour.

κ. ab. *lutescens-basalis*, n. ab.—Anterior wings with spots 1 + 2 joined to 3 + 4, 5 separate; the spots and the hind-wings yellow in colour.

λ. ab. *lutescens-glycirrhizae*, n. ab.—Anterior wings with 1 + 2, and 3 + 4 + 5, forming two blotches; the blotches and the hind-wings yellow in colour.

μ. ab. *trivittata*, Speyer, "Stett. Ent. Zeit.," xxxviii., pp. 40 *et seq.*—The anterior wings, with the spots forming three streaks, as in *A. purpuralis*, *viz.*, 1, 2 + 4, 3 + 5. (1) The upper basal spot extended along the costa to the middle of the costal margin. (2) 3 + 5 forming a discoidal streak, separated from 1 by the black subcostal nervure; this is rounded on its outer margin, is of almost uniform thickness in its outer half, but finely pointed between the stems of the subcostal and median nervures. (3) 2 + 4 united to form the broadest of all the streaks, and is wider at the middle of the wing than at the base. The posterior wings with a rather broad black border, which is continued along the inner margin to the base. The fore-wings are of a deep blue-black colour, the streaks of a brilliant crimson hue, the hind-wings of a lighter red.

All the aberrations in which the spots are united so as to form three distinct cuneate spots, more or less similar to that described, are included under this name by Speyer. Fletcher says that ab. *trivittata* undoubtedly occurs in Britain. He has, from Christy's Emsworth colony, the following transitional forms: (1) Seven specimens with basal spots normal, but with 3 + 5 united. (2) One specimen of the *trivittata* form on the right fore-wing, on the left fore-wing 2 + 4 are dilated towards each other, but do not form a streak; in these the united 3 + 5 are separated very narrowly from 4 by the median nervure. Some of the ab. *glycirrhizae* are evidently built up from the intermediate *trivittata* (1) by the union of 3 + 5, and (2) by the junction of 4 with 3 + 5.

ν. var. *syracusia*, Zell., "Isis," 1847, pp. 301-3; Freyer, "Neu. Beit.," vi., p. 39, pl. 506, figs. 3-4 (1847); Staud., "Cat.," p. 47 (1871); Curò, "Bull. Soc. Ent. Ital.," vii., p. 197 (1875); Oberth., "Études," i., p. 33 (1876); Hofmn., "Die Gross-Schmett.," p. 35 (1887). *Australis*, Led., "Verh. z.-b. Ver. Wien," ii., p. 71 (1852). *Trifolii*, Ramb., "Cat. Lép. And.," p. 177, pl. i., figs. 5-8 (1858).—Alis anterioribus obtusiusculis nigro-viridibus, maculis quinque minutis puniceis; posterioribus rubris margine lato chalybeo. *b*. Macula tertia-punctiform. *c*. Macula tertia venam subcostalem viridi-nigram excedente. *d*. Maculis 3 et 4 coalitis. LARVA: Pale yellow, with a black, yellow-spotted head; 4 rows of black spots; above the lateral (? supraspiracular) rows the hind-margin of the segments is lemon-yellow in colour. The two dorsal rows of spots are nearly as broad as the segments; they are deep black, emarginate above, with a spot of the ground colour in the middle. In the lateral (? supra-spiracular) rows each segment has two spots, one near the front margin, the other at the hind margin; the former is produced beneath into two points, which are sometimes separated from it as a confluent spot; the second is smaller, longish and concave above; in the concavity lies the lemon-yellow spot of the hind-margin, which reaches as far as the dorsal row of black spots. The lateral (? sub-spiracular) spots form a black longitudinal band. The anal plate is of a deeper yellow than the ground colour, and has in front of the hind margin a black transverse line, and in front of this, right and left, a black dot. The anal prolegs are coloured like the anal plate, and have on the side a blackish dash, emarginate above. There is a grey, median, longitudinal ventral band. COCOON: Somewhat slender, almost spindle-shaped, a little shorter and thicker at the upper than at the lower end; straw-coloured, shiny, and with 6 to 8 irregular longitudinal ridges, of which some extend the whole length of the cocoon, others are shorter, and join the longer ones before reaching the end of the cocoon. Common at Syracuse. The larvæ were not rare in a meadow where *Juncus acutus* grew in plenty, on the culms of which they generally make their cocoons. The insect inhabits damp meadows, the imago sitting on thistle-flowers. The earliest emergence was observed on May 4th, and the imagines lasted until the middle third of the month (Zeller). Sicily: Syracuse (Zeller), Ficuzza, Caronie, Medda (Calberla). Algeria: Géryville, etc. (Oberthür). Spain: Catalonia, etc. (Brit. Mus. Coll., *teste* Tutt).

Zeller considered the insect very near *A. trifolii*, and states that he brings it forward as a distinct species with but little confidence. He is induced to do this, however, by the small size of the spots on the fore-wing, the very broad black margin of the hind-wing, and the striking basal spot of the same colour, which runs as a broad stripe along the inner margin as far as the hind margin, and is accompanied by some black scales on the adjacent part of the wing. The wings of *syracusia*, he says, are also somewhat broader posteriorly, and more rounded at apex. The ♀ has larger spots than the male. The antennæ and legs agree with those of *A. trifolii*. Zeller took the insect for *A. trifolii* at the time, although struck by its early appearance (the latter insect not occurring till July and August, in Silesia). The insect is diagnosed (*Cat.*, p. 47) by Staudinger as: "Minor, al. ant. maculis parvis, disjunctis, post. margine lato nigro (Sicily, Ital. mer., Hisp., Mauritanica)." Zapater says, common in June, in Spain, its chrysalis is found on rushes. The specimens in the British Museum collection, some of which are Zeller's original examples, show them to be a somewhat small form of *A. trifolii*, 25-30 mm., the spots small and generally quite separated. Other specimens are labelled from Catalonia, and these run from 24-30 mm. (The Guernsey examples appear almost inseparable from this variety.) One small example has a very broad black margin to the hind-wings, similar to an example Mr. Prout obtained at Broxbourne. Curò notices it as a very small form, with the small spots of the anterior wings not confluent, and with a wide black margin to the posterior wings. The main characters of the larva, as given by Zeller (*supra*), are those of that of the early form of *A. trifolii*, and the differences given by Speyer (*Stett. Ent. Zeit.*, xxxviii., pp. 40 *et seq.*) between the larvæ of *A. syracusia* and *A. trifolii* are simply those existing between the larvæ of the "early" and "late" forms of *A. trifolii*, the latter of which seems to have been the form Speyer obtained (although he speaks of certain imagines he bred as belonging to the small-winged form), so that he evidently knew and obtained both forms. Three very fine examples sent to us by Oberthür, and captured by Lahaye, at Géryville, Algeria, May 10th-20th, 1886, are of the bronzy-green form in both sexes, the fore-wings rather narrow and the hind-wings with a very broad hind margin. They are much more like some of the ab. *orobi*, that Christy obtains at Emsworth, that Battley has sent us from Broxbourne, and Parry from Wye, than any other *trifolii* we have seen. Oberthür notes *syracusia* as very common at Lambessa, and adds that it does not vary. He states that this is the only Anthrocerid that, in his knowledge, is found both in Algeria and Europe. All other Algerian species, he says, appear to be confined to Africa, and are not to be found on the opposite coast of the Mediterranean.

ξ. var. *seriziati*, Oberthür, "Études d'Ent.," i., p. 33 (1876); iii., p. 41, pl. v., fig. 7 (1878); xiii., p. 21, pl. viii., figs. 71-73 (1890).—Resembles much certain varieties of *A. trifolii*, spoken of by Rambur (*Cat. Sys. And.*, p. 177, pl. i., figs. 5-8), but probably a distinct species. In any case, it is a most striking race, and should be designated by a name. Compared with *A. trifolii* it is a little larger; it has similar spots on the upper wings, which vary in size, but do not tend to be confluent. The lower wings are more rounded than in *A. trifolii*. Sometimes they are red, broadly bordered with blue, more often the red is invaded by the blue, but always leaves two red spots, one round in outline, towards the outer angle, the other elongated, rather indefinite, and having its origin at the base of the wing. The special character of *A. seriziati* is its tendency to have the inferior wings invaded with blue. It is very common at Collo (Oberthür).

This insect has certain close connections with *A. stoechadis* (*caucasia*, Bdv.); it should not, however, be confused with the latter, (1) because the green areas are blue in *seriziati*, (2) all the vinous-red portions of the wings in *stoechadis* are of a scarlet-vermilion tint in the Algerian species. These differences are constant, and as a result the two insects have a different aspect. It has many very striking characters which distinguish it at once from *trifolii-syracusia*, *trifolii-palustris* and *trifolii* from southern France. It appears to inhabit the littoral region of Algeria from Bona to Collo; the var. *syracusia*, on the contrary, is found among the low mountains of the interior, at Lambessa, Géryville, etc. The two insects have not yet been found together (Oberthür). Judging from a couple of specimens M. Oberthür has kindly sent to us, we can only say that the insect is a most striking form, and that, in spite of its brightly-coloured blue fore-wings and the very broad marginal border of the hind-wings, it has a most marked *trifolii-palustris* aspect.

ο. var. *gracilis*, Fuchs, "Stett. Ent. Zeit.," xli., p. 118 (1880).—Smaller and slighter than *A. trifolii*. The fore-wings, from base to tip, 13 mm.; dark blue-green, with five crimson spots, the third spot small and always separated from the fourth. Hind-wings red; the border narrower, the black colour rather produced in the centre and at the apex. Abdomen black. The antennæ long, extending farther than the fifth spot, with a thin knob ending in a small tapering point.

Fuchs notes that his specimens (3 ♂ s) were captured in July in a dry sunny meadow near Bornich, and were at first taken for ab. *orobi*, but he considered that although they might belong to a local form of *A. trifolii*, their characters necessitated comparison with *A. meliloti* and *A. lonicerae*; thus *gracilis* is a little larger than the former, it has similar markings, and narrow border to the hind-wings, but differs in the shape of the wings, and in having much longer antennæ with a more tapering point. The antennæ of *gracilis* are identical with those of *A. lonicerae*; it is at once to be distinguished from it, however, by its smaller size, rounder apex of fore-wings, and by the small size of the third spot. It agrees with typical *A. trifolii* in wing-shape, but differs in its small size and more slender build, in having longer antennæ, and in the narrower marginal border of hind-wings (which, however, varies in *A. trifolii*). Fuchs, however, concludes by suggesting that it is an aberration of *A. trifolii*, and states that the typical form of *A. trifolii* also occurs at Bornich.

Ovum.—The ova are laid in groups, each egg being attached by its long side to the object on which it is laid; they are also slightly attached to each other. The egg is of a bright yellow colour; the shell shiny (with many pieces of the dark scales of the imago attached to surface); roughly cylindrical in shape, the outline being somewhat oval, with a long oval depression on the upper side, roughly, the length : breadth : height : : 10 : 7 : 6. The two ends vary in different eggs; in some, the micropylar end is broader than its nadir, in others there is practically no difference between them. The micropylar end is, however, flattened, and in the centre of this end is a distinct crater, somewhat shallow, with a very simple stellate structure at the bottom of it. The egg is finely, and very faintly, ribbed longitudinally, the space between the ribs being reticulated irregularly. These ribs look almost like parallel striations, and 10 were counted on the upper surface of one egg, some of which crossed the central depression. At the micropylar end, this irregular reticulation becomes roughly hexagonal, and the longitudinal ribs fail; they are also absent at the opposite end, where, however, the irregular reticulation is less distinctly polygonal in form. There are some depressions in the egg, caused apparently by pressure, and the whole character of the egg suggests an exceedingly delicate structure. [Eggs laid on June 8th, 1897, received from Mr. Christy, and described on June 10th, under a two-thirds lens.] Hellins describes the egg as oblong and rather flattened, rather over 1 mm. in length, and about ·7 mm. in width, the upper surface sunk, the shell thin and rather glistening, wrinkled longitudinally, colour full yellow but rather pale in tint.

Habits of larva.—Some larvæ which hatched about the end of June (1864), were, Hellins records, 4-5 mm. in length when hybernation commenced. Another batch, in 1865, were half as long again at this period. When preparing to hybernate they congregate in little companies, each larva spinning for itself a silken pad, in order to obtain a firm foothold. Luff informs us that on one occasion he found young larvæ of this species hybernating with the larvæ of *Melitaea cinxia*, in a pear-shaped winter nest of the latter that was placed in the centre of a tuft of grass. During the winter the larvæ become very pallid in colour, and Hellins suggests that this is for a protective purpose, the torpid larvæ closely resembling the withered stems of their food-plant. They become active again in February, and go on feeding, although at very different rates. Some feed up rapidly, and are full-fed by the end of April and early May, others feed up slowly, and whilst the others are preparing for pupation, commence to hybernate (and æstivate) again, and feed no more until the following spring, passing another winter in the larval state. Luff found very small larvæ in Guernsey, on April 7th, 1875, and almost full-fed ones May 10th, 1874. The cocoon of this species is very difficult to find in its native haunts, and appears usually to be placed quite close to (or upon) the ground.

Larva.—The *hybernating* larva of *A. trifolii* is a very glassy-looking and colourless caterpillar, the skin being almost transparent, and covered with minute pits. *Dorsally:* The head is invisible, being retracted within the prothorax. The longitudinal mediodorsal band is very glassy-looking; on either side of this, are the subdorsal bands, bearing on each segment the large bosses formed on each side, by the union of the anterior and posterior trapezoidal groups. The two longitudinal areas containing these cushions or warts are pale brownish. The segmental incisions are very marked, each incision having a considerable basin-like depression mediodorsally, the depression extending to the segment before and behind the incision. On the meso- and metathorax the dorsal warts are almost united. On none of the segments (thoracic or abdominal) are the subdorsal tubercular cushions readily divisible into the two parts of which they are formed. Each mass bears about ten glassy-looking, pale amber, spiculate hairs, each arising from a dark tubercular point. There are no dark patches between the dorsal warts. *Laterally:* There is a longitudinal area running between the subdorsal and supraspiracular warts; in this, on the hinder margin of each segment, is an inconspicuous, transverse, yellow patch. The supraspiracular cushion is large and prominent. The spiracles are black-ringed and not standing out (as in the larva of *A. hippocrepidis* in hybernating stage). The subspiracular and marginal tubercles also form raised cushions with a ring of dark points bearing hairs and a larger central one. [There are no black hairs, dorsally or laterally, on the larva in this stage.] *Ventrally:* The skin is almost transparent and glassy-looking. The head pale brown, the mouth-parts paler. The true legs and prolegs have the same glassy-looking appearance as the ventral surface; the true legs with a few short white hairs at the joints, and a single minute terminal claw; the prolegs with an inner flange of about 10-12 very small black hooks. On January 24th, 1897, a larva in the stage just described moulted, and assumed at *this instar* the plumage characteristic of the adult Anthrocerid. It is now of a clear white ground colour, the opacity remarkable, considering the transparent condition of the previous stage, the skin still pitted, and the incisions somewhat yellowish. *Dorsally:* There is a broad, longitudinal, mediodorsal band of the ground colour. The anterior and posterior trapezoidals unite to form a large subdorsal mass or cushion on either side of each segment; the inner part of the mass bears eight minute blackish tubercular points, each with a transparent, white, glassy-looking spiculate hair; the outer part also bears eight blackish points, seven arranged in a circle, each bearing a black hair and one central point bearing a much longer whitish one. Between these warts (on successive segments) is an intensely black velvety patch; part of each patch being on the segment anterior and part on that posterior, to the incision falling between the warts. The prothorax has the subdorsal warts united. The supraspiracular warts are conspicuous viewed dorsally. *Laterally:* The pale longitudinal band separating the dorsal bosses from the supraspiracular warts is traversed by a series of transverse conspicuous bright primrose-yellow patches. These commence on the posterior margin of the mesothorax, and are continued on the posterior margin of each of the successive segments. Each of the supraspiracular warts forms a large boss or cushion with from 10-13 small black points, each of which bears usually a short, white, spiculate hair. A few of these hairs, however, are black (mesothorax, 10 hairs, of which the five upper are black; metathorax 10, the upper one only black; 1st and 2nd abdominals 10, no black; 3rd, 4th, and 5th abdominals 13, upper one black; 6th abdominal 12, no black; 7th abdominal 15, no black; 8th abdominal 10, no black; 9th abdominal 13, upper one black; anal, large lateral boss, 20 hairs, three black). The prothorax has the subspiracular tubercle modified into a prespiracular wart or cushion; the meso- and metathorax have supra- and subspiracular warts. The supraspiracular boss extends narrowly behind the spiracle, and is united posteriorly with a somewhat similar subspiracular boss, carrying eight minute dark points, each bearing a short, white, spiculate hair, seven of which form an outer ring, enclosing one centrally. Just above the level of the spiracles, and placed between the supraspiracular warts, is a series of small brown patches, partly covering that portion of the two segments between the supraspiracular warts. This gives a distinctly dark appearance to the supraspiracular line. At the base of the prolegs is another series of tubercular cushions, rather smaller than, but otherwise similar to, the subspiracular warts. Each marginal wart consists of eight tubercular points, bearing white hairs. There are no black hairs below the spiracles. The spiracles consist of a black circular ring with a distinct white central orifice. *Ventrally:* The skin is glassy-looking and transparent, pale yellowish in the incisions. The legs and prolegs are of the same pale colour, the former bearing a minute whitish hook, the latter with an inner flange bearing about 12 small black hooks. The head is smoky-black (a little slaty) in colour, with a white labrum, and white ring at the base of the antennæ, the ocelli black. [We are indebted to Mr. South for the larvæ from which these descriptions were made on Jan. 25th, 1897.] Hellins also has described the larva at the commencement of the *hybernating instar.* He says that it is then of a green tint with rows of black spots, and that this colouring is not affected by the variation in size which was found to exist in different years, when hybernation commenced. During the hybernating period, however, the larvæ become semi-translucent and dirty white in colour; their rows of spots are changed to reddish-brown, a pair of small dots only on each segment being black, and their bristles seem more prominent. They commence feeding again in February, and, *after their first spring moult*, are of a greenish-grey colour, with a row of pale primrose spots on each side of the dorsal rows of black X-like spots. When *full-fed* the ground colour becomes much brighter, and is then of a bluish-green or of a rich yellow-green; but the two dorsal rows of black spots retain their X-like character. Briggs gives a much fuller description of the *adult* larva, which he describes as having "the body with short white hairs scattered over it, and with a very few black hairs on the back. The head and prolegs black; the transverse upper lip and membrane at base of antennæ white. The ground colour pale yellowish, arranged in five lines, one mediodorsal, and two lateral on either side. On each side of the dorsal line is a row of large black spots, two on each segment, confluent, or nearly so, but each coming to a point on the back, which makes the dorsal line look like a row of transverse lozenge-shaped spots on the middle of the back of each segment, preceded and followed by semi-lozenge-shaped spots, which unite (or nearly so) with those of the following and preceding segments; the anterior spot terminates lower down the segment than the posterior. On the thoracic segments, the dorsal line is so narrow and dusky as to be hardly perceptible. Below the dorsal rows of black spots there is a longitudinal line of the ground colour, with a bright yellow spot in each segmental incision, formed by the hind margin of each segment. Below this is another row of black spots on each side, composed of two spots on each segment, which are confluent, or nearly so, at their lower extremities, and giving them, when confluent, a horse-shoe appearance. In this row of black spots the spiracles are placed. This spiracular row is followed in turn by another longitudinal band of the ground colour, in which, on each segment, are two subspiracular black dots, one on the anterior and one on the posterior fold, the anterior dot being placed rather lower than the other. The space between this band and the prolegs and true legs is nearly filled up with blackish and dusky markings, some segments being more suffused than others. The prolegs and ventral area pale, with a row of dusky dots down the medioventral line." Boisduval describes the larva as "verte ou d'un jaune verdâtre plus ou moins clair, pubescente comme ses congénères; elle a quatre lignes de points noirs, dont deux dorsales et les autres latérales; on remarque en outre sous le ventre un petit point noir sur chaque anneau." The X-like dorsal marks, the lateral horse-shoe-shaped spiracular spots, the ventral "petit point noir" are all very characteristic of the larva of this species.

Comparison of A. trifolii larva with that of A. palustris (trifolii-major).—The larva of *A. trifolii* is smaller than that of *A. palustris* (*trifolii-major*). The latter has the black dorsal spots on each segment separate, whilst the former has them united and X-shaped. The larva of *A. trifolii-major* has the spiracular row of black spots such that there are two distinct spots on each segment; in that of *A. trifolii* they are united into a spot, the form of which roughly resembles a horse-shoe (Briggs). We can corroborate Briggs entirely as to the general constancy of these differences, although it would appear that in some larvæ of *palustris* the spiracular spots attain the horse-shoe shape, and it is possible that the intermediate races would, in their larvæ, show intermediate characters. The comparison of the larva of *A.* var. *syracusia* with that of *A. palustris*, given under the latter species, is practically a further differentiation of the larvæ of the two forms here considered.

Comparison of A. trifolii larva with that of A. filipendulæ.—Hellins thinks that the X-like character of the black dorsal markings (when the segmental incisions are hidden) is the chief distinction by which the larva of *A. trifolii* may be distinguished from that of *A. filipendulae*, the dorsal rows in the latter being formed of a broad and a narrow spot on each segment. He further states that the former is smaller, the ground colour probably more yellow, and the black spots in the lateral rows also smaller than in *A. filipendulae*.

Cocoon.—The cocoon is of the same general form as those of the allied species, but those described, received from Mr. Christy, were spun up on a piece of leno, and not attached to a grass-culm or stalk of some herbaceous plant. They are smaller than those of either *A. filipendulae* or *A. palustris*, averaging about five-sixths of an inch in length and a quarter of an inch in width centrally (widest part). The base, owing to the surface on which the cocoons were spun, is broad and flattened, otherwise the cocoon is fusiform in shape; the ends rounded and somewhat blunt; the upper end rather thinner than the rest of the cocoon. It is of very delicate structure, pale yellow, inclining to whitish, in colour, uniformly tinted all over the surface, although the cocoon is much more loosely spun laterally than in front. The outer surface is shiny, as though varnished. The inner surface is lined with some very fine, loose, flossy, white silk. Hellins says that he had a cocoon which was quite white. The upper end of the cocoon dehisces medially to allow of the escape of the pupa, although there is a smaller lateral slit on either side in some cocoons. The pupa emerges as far as the second abdominal segment before the imago is excluded, the pupa-case remaining fixed in the cocoon in this position after the emergence of the imago. Boisduval describes the cocoon as "allongé, sillonné, et d'un jaune paille, avec la partie inférieure blanchâtre." The cocoon of *A. trifolii* (*-minor*) is rarely spun on a grass-culm or stalk of a herbaceous plant, but low down, either upon or near the ground. With regard to the formation of the cocoon, an observer notes (*Pet. Nour. Ent.*, ii., p. 243) that the larva first spins the lower part of its cocoon, in which it rests, whilst it makes the upper part, which it completes by uniting the two parts together, and when enclosed makes the structure more solid, the whole operation having occupied from 2·0 p.m.-6·30 p.m. He says that the larva covers the basal part with a golden-yellow liquid, and observed it eject the latter as a viscid secretion from the anal orifice, turning itself at once to spread the varnish, the lower part being first done, the upper part afterwards. He further noticed that, after the colouring matter had been spread, the larva arched itself in order to keep up the damp part until it had dried, a result that happens very quickly. The larva curled itself backwards, horseshoe fashion, to deposit the material, three ejections being necessary to complete the whole process. Chapman notes that the pupa keeps its venter towards the attachment of the cocoon. When the pupa liberates itself from the cocoon, the latter splits dorsally for fully one-fourth of its length, and there are two lateral slits. The two flaps so formed are forced out, but, being very elastic, press inwards, and try to close the slits. The pupa pushes itself out until the 4th abdominal segment is opposite the end of the dorsal slit, and the posterior margins of the wing-cases engage in the lateral slits, the ends of the flaps falling into the hollow on each side of the first abdominal segments that form the waist. As the moth emerges, the elasticity more or less closes the slits on the empty pupa-case, pinching it up into folds.

Pupa.—The pupa is blackish-brown, shiny; the surface finely pitted, and with a somewhat silky appearance under a lens; the abdominal segments greenish-black, and all but the three terminal, almost transparent; a distinct waist at 2nd abdominal; the 8th-10th abdominal segments narrow very rapidly. *Dorsal view:* The dorsal head-piece prominent; the prothorax well-developed; the mesothorax large, prominent, swollen medially, and with a distinct shoulder at the base of the wings; the metathorax narrow centrally, widening at sides and carrying the hind-wings, which extend conspicuously beyond the base of the fore-wings, the base and outer margin of the hind-wings being exposed. The 1st abdominal segment of the same black colour as the thoracic segments. The 2nd-7th abdominal segments very delicate, the skin almost transparent and smooth, except for a row of very fine, closely set, minute, black hooks on the front edge of each segment, the membrane of the segmental incisions quite transparent. The 8th and 9th abdominal segments are much smaller but more opaque, shining, blackish, and the hooks are better developed and set rather further back on these segments. The cremaster is shining, black, turned back dorsally, the tip studded with numerous black points. The lateral longitudinal grooves on the dorsum of the mesothorax are very marked, and formed of semi-transparent chitin. Some variation in the colour of the abdominal segments occurs; this is especially liable to be the case in immature examples. *Ventral view:* The mouth, mouth-parts and wings black, the appendages rather less black, the abdominal segments 1-4 quite transparent, but faint blackish in hue; the remaining segments more opaque and blacker. The maxillæ and third pair of legs free and extending to the venter of the 6th abdominal segment. Each abdominal segment bears ventrally two depressions, occupying the positions of the larval prolegs; the anal organs sloping ventrally, rough; the genital organs prominent on the 8th or 9th abdominal segments (according to sex). *Lateral view:* The glazed eye is a smooth shiny blackish-brown lunule, extending from the base of antenna to the first pair of legs; the wing-neuration is very distinct, the spiracles small, black, and inconspicuous, placed posteriorly on the segments; the two depressions above each spiracle represent the positions of the subdorsal (i and ii) and the supraspiracular (iii) tubercles of the adult larva; the cremaster prominent. Hellins notes that some pupæ that he measured were about 2 mm. shorter than those of *A. filipendulae*, but that he could detect no other difference between them. Webb states (*Ent. Record*, vii., p. 255) that the pupa sometimes goes over the winter, the imago emerging the next year. We have little doubt this is an error. Apparently living pupæ do go over the winter, but such pupæ always produce a parasite the next summer. It is the pupa of the parasite, and not of the moth, we believe, that lives through the winter.

Dehiscence.—The dorsal head-piece carries the antennæ, glazed eye and maxillæ; the pro- and mesothorax split mediodorsally, to posterior margin of mesothorax, and carry the wings, the surfaces of both fore- and hind-wings being completely separated and free from the abdominal segments; the maxillæ and third pair of legs retain their position, but the first and second pairs of legs separate independently; the abdominal incisions 2-3, 3-4, 4-5, 5-6, 6-7, are stretched out widely, and exhibit conspicuously the transparency of the connecting membrane.

Food-plants.—*Trifolium procumbens*, *Lotus corniculatus*, *Hippocrepis comosa* (Boisduval), *Lotus corniculatus* (Hellins, Briggs), *Polygonum aviculare* (Machin), *Trifolium procumbens*, *Lotus corniculatus*, *Coronilla varia* (St. John). [Lafitole records (*Pet. Nouv.*, 1876, p. 62) a larva found feeding on oak. There is, one would suppose, some error here.]

Parasites.—*Casinaria vidua*, Holmgren, bred by Weston (Bignell), *C. orbitalis*, Gr., and *Cryptus zygaenarum*, Ratz., have also been bred from this species.

Habitat.—The early form of this species usually prefers a moderately dry habitat, and occurs generally in meadows, pastures, chalk downs, hillsides, and similar places. Near Wye, and at Emsworth, it is found on the chalk downs, at Abbott's Wood in damp meadows on the clay. Near Strood it occurs in quite dry mowing meadows, whilst in the New Forest it is found in the rides of some of the woods, and Bayne has taken it both on the heaths and bogs there. It also occurs on a heath nr. Bideford. Lifton says that it haunts grassy slopes on the Cotswolds; about Harrow it occurs on the hillsides, whilst at Polegate it is found in a dry field among the woods, and in Lundy Island, on waste land, somewhat high. In Guernsey, it is found on the cliffs (Lowe), and in Pomerania in open woods (Hering). Peyerimhoff says that it inhabits damp fields in the plains and mountains in Alsace. Boisduval notes that he has seen this species (*? palustris*) in the damp fields of the French Alps so abundantly that the branches of *Hippophaes* have been covered, so to speak, with their cocoons. Oberthür says that both *A. trifolii* and *A. filipendulae* occur in Brittany, in a granite and schistose district with little tendency to be calcareous, whilst Dupont notes it as being found in meadows with *A. statices*, nr. Havre, and on the chalk-hills (in less dry places than those affected by *A. carniolica*, etc.) nr. Pont-de-l'Arche and Dieppe.

Time of appearance.—No species is more subject to variation in its time of appearance than this, yet, for the same place, the dates are generally fairly constant. It appears in late May and June with *A. statices* at Basingstoke, nr. Strood, Broxbourne, Taunton, Hursley, Emsworth, Abbott's Wood, Winchester, Rickmansworth, etc.; middle June in Guernsey; late June and early July in the New Forest, and mid-July (*? palustris*) at Sandown in the Isle of Wight. In mid-July the *palustris* form is well out on the eastern coast, and emerges until August at Swanage, Freshwater and King's Lynn. Fletcher has, in confinement, bred a few autumnal imagines from eggs laid the preceding spring (*vide*, p. 418). Lowe, on October 9th, 1894, found a freshly emerged specimen resting by its pupa-case, in Guernsey. This may have been a second-brooded example, or an individual that had begun to æstivate for a second year, and was afterwards induced to feed up. This is a similar occurrence to Girard's experience (*ante*, p. 418). The following are recorded dates: June 26th, 1856, at Grimstone (Balding), June 10th, 1859, at Shorncliffe (Rogers), June 18th, 1860, at Barnstaple (Mathew), June 16th, 1864, worn, at Barnwell Wold (Briggs), June 13th, 1870, June 11th, 1871, at Battle (Jenner), June 13th, 1872, June 24th, 1874, fine, July 12th, 1875, fine, in Guernsey, June 25th, 1874, worn, in Sark (Luff), June 9th, 1874, worn, nr. Winchester, (Richardson), June 15th, 1882, June 9th-11th, 1883, June 13th, 1890, June 25th, 1891 almost over, May 29th-June 8th, 1892, May 18th, some worn, June 9th, 1893, May 24th-June 18th, 1894, May 27th-June 12th, 1895, May 21st-June 6th, 1896, May 29th-June 12th, 1897, June 5th-June 19th, 1898, nr. Emsworth (Christy), May, 1883, at Cambridge (Watson), June 14th, 1883, at Ruislip (Watts), June 16th, 1883, at Chattenden (Tutt), June 12th, 1884, June 15th, 1885, June 18th, 1886, June 18th, 1895, June 1st, 1896, June 15th, 1898, October 9th, 1894, in Guernsey (Lowe), May 23rd, 1889, at Bramshill, June 1st, 1890, at Butterwood, Odiham (Holland), June 1st-13th, 1889, at Mill Hill, May 27th-

June 3rd, 1893, June 14th-21st, 1894, at Abbott's Wood, June 27th, 1896, worn, at Wormley West End (James), July 4th, 1889, on rushy ground, at Matley Bog (C. Nicholson), July 26th, 1890, at Lyndhurst (Simes), June 9th, 1890, at Hailsham (Fox), June 28th, 1890, in the New Forest (Blagg), June 2nd, 1892, at Abbott's Wood (Porritt), June 11th, 1892, at Rickmansworth, May 22nd, 1893, at Northwood (South), July 3rd, 1892, July 1st, 1894, July 5th, 1895, in the New Forest, June 20th, 1894, June 21st, 1895, at Broxbourne, worn (Bayne), captured May 12th-June 17th, 1893, bred May 20th-June 2nd, 1893, early year, June 25th, 1894, late year, nr. Swanage (Bankes), June 5th-7th, 1898, at Abbott's Wood (Clarke), June 30th, 1894, fine, a late year, at Wormley Common (Prout), June 5th, 1895, well out, at Ashford (Crabtree), June 5th, 1897, at Brooke, I. of Wight (Kaye), June 19th, 1897, nr. Painswick (Lifton). Ochsenheimer found it fine in the commencement of June, nr. Leipzig, noting it as being earlier than *A. lonicerae*; June 21st, 1891, nr. Dieppe, on the cliffs, June 10th-15th, average time of emergence, lasting about a month, one year as late as July 31st, on a hill nr. Pont-de-l'Arche, June 4th, 1896, nr. Le Havre (Dupont).

Localities.—There is no possibility of separating the localities of *A. trifolii* proper from the usually later-appearing *A. palustris*. The following approximate list, therefore, alone can be offered: Ayrshire: occasionally (Dunsmore). Berks: Reading (Hamm). Cambs: Horningsea (Stephens). Devon: Axminster (Bowerman), Barnstaple (Mathew), nr. Bideford, on heath on Abbotsham Road (Bostock), Lundy Island (Chase *teste* Martineau), Dartmoor (Still). Dorset: Hambledon nr. Shillingstone (Fowler), Weymouth (Blackmore), Poole (Green), Portland, one specimen (Partridge). Essex: Hainault (English). Flint: Holywell (Archer). Gloucester: nr. Gloucester (Marsden), Woodchester nr. Stroud (Mackey). Hants: Ampfield (Hewett), Emsworth (Christy), Brockenhurst (Stephens), Lyndhurst (Simes), Hursley (Moberly), Portsmouth, Purbrook (Pearce), Denmead (King), Basingstoke (Hamm), Matley Bog (C. Nicholson), Bramshill, Butterwood, Odiham (Holland), Winchester (Richardson), Christchurch (Fowler). Hereford: Tarrington (Wood), Leominster (Hutchinson). Herts: Broxbourne (Battley), Wormley Common (Prout). Isle of Wight: Brooke (Kaye). Kent: Folkestone (Briggs), Shorncliffe (Rogers), Chattenden (Tutt), Canterbury, Wye (Parry), nr. Ashford (Crabtree), Buckland (Stonestreet). Middlesex: Ruislip (Watts), Mill Hill, Rickmansworth (South), Harefield (Wall), Kingsbury (Bond), Stanmore Common (Rhoades-Smith), Pinner Drive, Oxhey Wood, Ruislip Wood (Melvill). Norfolk: Horsford nr. Norwich (Pitman), Grimstone (Balding). Northampton: Barnwell Wold (Briggs). Northumberland: nr. Newcastle (Stephens). Oxford: Shotover Hill (Briggs). Rutland: Uppingham (Bell). Somerset: Taunton (Parish), Bath (Merrin), Clevedon (Mason). Stafford: Cannock Chase (Freer and Bostock). Suffolk: Tuddenham, Ipswich, Felixstowe, Beccles, Herringfleet (Bloomfield). Surrey: Camberley (Watson), Haslemere (Barrett). Sussex: Battle (Jenner), Hailsham (James), Abbott's Wood in the "Long Meadow" (Porritt), Polegate (Prout), Hastings (Atkinson), Chailey, Hayward's Heath and Brighton (Jenner), nr. Worthing (Fletcher). Wales: North Wales (Walker). [It may be here noticed that there is no absolutely reliable record of this species for Scotland or Ireland. Birchall gives it as local in Galway, Kirby gives it as inhabiting the West Shannon district (Connaught), Partridge mentions it as occurring at Enniskillen, June 2nd, 1893, and it has been recorded from Armagh, but Kane thinks with us, that all these want confirmation, and that the specimens captured were probably *A. lonicerae*, a common Irish species. *A. trifolii* has been recorded from Forfar, and Dunsmore mentions that it is reported from Ayrshire, but these also want confirmation.] Luff mentions its occurrence in Sark, Herm and Guernsey.

Distribution.—Africa: North-west Africa (Staudinger). Asia: Obi and Yenesei districts (Erschoff), Amasia and Tokat (Speyer), Pontus (Staudinger), Altai mts. (Kindermann). Austria: Heiligenblut to 4,000 ft. (Staudinger), nr. Vienna, Carniola, Buda (Speyer), Hungary (Boisduval), West Galicia, Lemberg, Lanckorona, etc. (Garbowski).

Belgium: common (Berce). Channel Islands: Guernsey, Herm, Sark (Luff). Denmark: rather common (Aurivillius). France: greater part of France, common, Compiègne, Auvergne, Gironde, Basses-Alpes, Le Doubs, Besançon, Pontarlier, nr. Autun (Berce), Uriage, Vernet-les-Bains, Brittany, Ille-et-Vilaine, Rennes, Banyuls-sur-Mer (Oberthür), Nohant, Forêts du Cher, Mont Dore, Crevant (Sand), Rheims district, common, banks of the Vesle and Suippe, Cormontreuil, Sillery, St. Hilaire-le-Petit (Demaison), Loire-Inférieure (Bonjour), Dept. du Nord (Dupont), Dept. l'Aube, Paris (Jourdheuille), Calvados, St. Quentin (Dubus), nr. Paris, Touraine, Périgueux, Tarbes, Marseilles, Perpignay (Rambur), Depts. of Meuse, Doubs, Puy-de-Dôme, nr. Aix (Speyer), Isère, Pyrénées-Orientales (Duponchel), Alpes-Maritimes (Millière). Germany: almost everywhere (Kayser), Baden, generally distributed, also in mts., Kaiserstuhl, etc., Alsace, Pfalz, Würtemburg, Nassau (Reutti), Prussia, Insterburg, Dantzig, Mannheim, Waldeck, Weimar, Krefeld, Ratisbon (Speyer), Thuringia, Ohrdruf, Tambuch, Georgenthal, Wanningsroda (Knapp), Silesia, Leubeusch (Prittwitz), banks of the Wiese (Homeyer), Stettin, on the Wiese and Plöne nr. Damm, nr. Finkenwald and Tantow, common (Hering), Hilden nr. Düsseldorf (Kirby), Leipzig (Ochsenheimer). Italy: widely distributed and moderately common in northern, central and southern provinces—Tuscany, Sicily, etc. (Curò), nr. Susa, Ligurian Alps, nr. Naples (Costa), Syracuse (Zeller), Piedmont (Boisduval). Netherlands: Overijssel—between Raalte and Wijke, Gelderland—Groenlo, Varsseveld, Zutphen, Arnhem, St. Michielgestel, North Brabant and Nijkerk, and ? Limburg (Snellen), Luxemburg (Speyer). Roumania: rare. Concorova (Mann), Turn Severin (Haberhauer). Russia: South Finland to 60° 41′ (Reuter), Nyland, Tavastland, Karelen (Lampa), Prov. Orenburg, Saratov, Kasan, Sarepta (Eversmann), White Sea to Urals, Moscow district, mths. of Danube to Dnieper, Volga dist., Transcaucasia (Erschoff), Poland (*teste* Caradja), Siebenbürgen (Speyer). Scandinavia: South Sweden, rare (Aurivillius), Blekinge (Wiström), Upsala (Fallander). Spain: Andalusia, Granada, Malaga (Rambur). Switzerland: appears sporadically in swampy meadows in June, and goes up mts. to 5,000 ft., St. Gallen (Täschler), Berne, Gadmen and mts. near Bagnethal, Simplon, Val Vedro (Rätzer), Bechburg (Stehlin), St. Blaise-Neuveville (Couleru), Lauterbrunnen (Christ), Valais (Jäggi), ? Bremgarten (Boll), ? Canton Glarus (Heer), nr. Zürich (Snell), Trafoi (Wocke).

ANTHROCERA TRIFOLII subsp., PALUSTRIS, Oberthür.

SYNONYMY.—Species: *Palustris*, Oberth., "Etudes," xxth livr., "Var. chez Lép.," pp. 44-46, pl. viii., figs. 151, 152, 153 (1896). *Scabiosae*, Haw., "Lep. Brit.," i., p. 74 (1803). *Loti*, Stephs., "Illus.," i., p. 109, vars. α et β (1829). *Meliloti*, Stephs., "Illus.," i., p. 107, *teste* Briggs (1829). *Trifolii* (the late form), Briggs, "Trans. Ent. Soc. Lond.," 1871, pp. 417 *et seq.*; Tutt, "British Moths," p. 353, in part (1896). *Trifolii-major*, Tutt, "Ent. Rec.," ix., pp. 88, 167 *et seq.* (1897). *Trifolii*, Bdv., "Icones," pl. liv., fig. 8 (1834); Hein., "Schmett. Deutsch.," p. 160 (1859); Speyer, "Stett. Ent. Zeit.," xxxviii., pp. 40 *et seq.* (1877).

ORIGINAL DESCRIPTION.—Boisduval had distinguished in his collection the Breton and Norman race of *Z. trifolii* under the name of *Z. palustris*, and we think that he had rightly appreciated the differences that exist between the south and west French races of this *Zygaena*. In the west of France, *Z. trifolii* is of a much brighter red than in the

Isère and the Pyrénées-Orientales, where the red portions are a little violaceous, and rather transparent; we have figured on pl. viii., fig. 150, a ♂ from Vernet-les-Bains. This represents the southern race of which Duponchel speaks (*Hist. Nat.*, supp. ii., p. 71, pl. viii., fig. 1). It presents a confluent aberration, but much more rarely than in the western race, *Z. palustris* (Oberthür, *Etudes*, etc., xxth livr., *Variation chez Lépidoptères*, pp. 44-46).

Imago.—Fore-wings greenish or purplish-blue, with five bright crimson spots—two basal (often confluent), two central (often confluent), and one towards apex. Hind-wings crimson, with a broad purplish hind-margin. [The females very rarely five-spotted, a very large proportion of this sex with the spots united into a longitudinal blotch.]

Comparative description of imago with those of allied species.—Expanse of wing 1″ 2‴ to 1″ 6‴. Much larger and stouter than *A. trifolii*. Antennæ thicker and shorter than those of *A. filipendulae* and *A. lonicerae*; those of the ♂ thicker than those of the ♀. The fore-wings with large red spots, the central and basal pairs often united, whilst all the spots frequently coalesce in the female (more rarely in the male). Hind-wings with a broad black border, especially in the male (Briggs).

Variation.—The general features of the variation of this form are identical with those previously described (*ante*, p. 485) as characteristic of *A. trifolii*. Oberthür has diagnosed two aberrations, as yet only known to occur in the *palustris* form.

α. ab. *sexmaculata*, Oberthür, "Variation chez Lépidoptères," pp. 48-49, pl. vii., figs. 151-152 (1896).—At the end of May, 1893, at Hublée, about 4 kil. from Rennes, amongst many *trifolii*, besides normal examples and several confluent forms, I obtained 7 specimens with 6 spots. No possibility of error could have occurred, as *A. filipendulae* does not occur at Hublée. In 1894, chrysalides were collected on the stalks of plants in this locality, 110 examples emerged, 25 confluent, 3 ♀ with 6 spots, the rest normal. In 1895, the species was rare, 25 examples were bred, 7 were confluent, the others normal, not a single specimen with 6 spots.

β. ab. *sexmaculata-confluens*, Oberthür, "Variation chez Lépidoptères," pl. vii., fig. 153.—This is a confluent form of the *sexmaculata* aberration, *i.e.*, it has the special characters of the latter, but the spots are united into a single longitudinal blotch.

Ovum.—The eggs are laid on their long sides, usually in small heaps, and generally in two layers, one above the other, the micropyles of the eggs, however, appearing to be always free. When laid in a single plane the eggs are just in contact. The egg is oval in shape, with equally rounded ends, and with a large, rather irregular, oval depression on the long side. The shell is shiny, and distinctly pitted, and there are many, moderately distinct, longitudinal folds (scarcely ribs) extending from the micropylar pole to its nadir. These cross over the shoulder of the egg, and terminate on the edge of a slight, regularly pitted depression, forming the micropylar area, at the base of which is a minute depressed cavity, the micropyle proper. There are many irregular depressions, evidently brought about by pressure. The egg is bright yellow in colour, the yelk occupying rather less than a half of the egg, the other portion being entirely transparent, but after a little disturbance the yelk becomes more or less distributed throughout the egg, which then becomes of an uniform bright yellow colour. After the larva leaves the egg, the egg-shell is quite transparent. [Eggs received from Messrs. Bacot and Clarke, on July 17th, 1897, described the same day under a two-thirds lens.]

LARVA.—Briggs describes (*Trans. Ent. Soc. Lond.*, 1871, p. 437) the *full-fed* larva of this species, as having the "body with short white hairs scattered over it, with very few black hairs mixed with the white on the back. The head and true legs are black; the transverse upper lip and membrane at base of antennæ, white; the ground colour pale yellowish, arranged in five lines, one dorsal, and two lateral on each side. The dorsal line is *broad*, yellower in the fold that is formed by the hind margin of each segment. On each side of the dorsal line there is a row of black spots, two on each segment, of which the anterior spot is the larger, somewhat semicircular with the flat side turned towards the anus, the posterior spot is narrow, curved on the anterior margin, approaching in shape to a lunule. On the prothorax the dorsal spots are confluent, the anterior being greatly reduced in size; the anterior margin of this segment, also, is partially margined with blackish, leaving the middle portion of the yellowish ground colour. Below the dorsal spots there is a broad pale yellowish line, with a yellow spot on the fold, formed by the hind margin of each segment, but this spot is *not* very conspicuous. Below this line, again, is another row of black spots on each side, two on each segment, of which the anterior is larger and curved backwards, and bears the black spiracles, but very *often* the lower portion of the spiracle-bearing spot is separated from the rest, and sometimes dwindles down to a mere dot. (There is no minute black spot below the smaller of the two lateral spots, as is often the case in the larva of *A. filipendulae.*) Below this spiracular row of spots is the lower lateral line, and between this line and the feet is a row of dusky spots bearing a pale, transverse lunule in the lower portion of each; this lunule is sometimes absent, or nearly so. A dusky, very narrow, streak extends along the base of the prolegs, the latter and ventral area yellowish, with a dusky interrupted line down the middle of the venter." On July 16th, 1897, we described a *full-fed* (dead) larva found in a cocoon (from the Norfolk coast) as follows: The head shining black, cleft at apex, several cream-coloured marks at the base of cleft, surface sprinkled with hairs. Body pale yellowish, with two longitudinal rows of black spots running down either side of the mediodorsal line, another on either side of, but separated from, these dorsal rows, by a longitudinal line of the yellow ground-colour. The small, indistinct, black spiracles are placed each in one of the black patches forming this row. There is another longitudinal subspiracular row of black spots on either side, and separated also from the spiracular row by a longitudinal band of the ground colour. Each of these rows of black spots is very similar; on each segment there is a large anterior, separated from a rather smaller posterior, black spot. The dorsal rows of black spots are much better developed than the lateral. The skin is covered with minute white points, bearing pale hairs. The tubercular warts bear stellate fascicles of black and pale hairs, and the abdominal incisions are very distinct. The warts are as follows: (1) Dorsal (i and ii united on each side of the mediodorsal line on each segment). (2) Supraspiracular (iii). (3) Subspiracular (iv and v united). (4) Marginal, just above base of proleg. These are placed four on either side of, or eight in a transverse ring around, each segment.

VARIATION OF LARVA.—Speyer notes (*Stett. Ent. Zeit.*, xxxviii., pp. 40 *et seq.*) that the ground-colour of the *full-fed* larva varies. Four (out of seven) larvæ were pale yellow, one lemon-yellow, and two pale greenish-yellow. The principal markings are the four longitudinal rows of black spots, of which only the upper pair are constant, and these are also very variable in size and shape. Four of the larvæ examined had both upper rows composed of two spots on each segment, of which the former is the larger, and either square or round, whereas the hind one is hollowed out on its front border, and is nearly half-moon shaped. The other two rows are also composed of two spots on each segment, of which the front one is generally placed rather lower down, and is larger than the hind one. Both are of an irregular, sometimes long, sometimes round shape. On the first two segments the spots are smaller, narrower, and the upper pair very often joined. Of the remaining three larvæ, two have the lower rows of spots represented by points, and the other has lost these altogether, with the exception of a single dot on the 4th and 6th segments. In these three larvæ the spots of the upper rows are also comparatively small, the front one is square on the middle segment, the back one is represented by two dots, one above the other; on the first five segments half-moon shaped. The lateral spots of the three most strongly-marked larvæ form a black longitudinal streak, or rather a row of spots, as the streak is interrupted by the segments. Of the remainder, two have, instead of the streak, an interrupted grey line, which is shortened in front and behind, and the other two have lost even these markings. In the place of the dorsal plate, two larvæ have a black spot on each side, and behind this a lateral stripe; these larvæ have also a broken grey line, reaching from the 4th to the 9th segment, along the middle of the venter. The remaining larvæ have not these markings. A small row of bright, yellow, lateral spots, placed between the upper and lower rows of dorsal spots on the hind border of each segment, is, however, quite constant.

COMPARISON BETWEEN THE LARVÆ OF A. PALUSTRIS (TRIFOLII-MAJOR), A. TRIFOLII AND A. FILIPENDULÆ.—We have given at length two descriptions of the larva of *A. palustris*, made in 1871 (Briggs) and 1897 (Tutt) respectively, and quite independently of each other, simply to show that they are identical, and because of the important bearing this has on what follows. In comparing our description of the larva of *A. palustris* (*trifolii-major*) with that of Buckler's *A. filipendulae* (*Larvae*, etc., ii., p. 98), we were astonished to find that the black spots of the dorsal stripes are arranged almost identically with those of the same stripes in *A. filipendulae*, *i.e.*, large and small, on each segment, and not X-shaped, as in the true *A. trifolii*, a character which Hellins says is the chief distinction between the larva of this species and that of *A. filipendulae*, L. (*Ibid.*, p. 96). As our larva was taken from a cocoon that was picked from a piece of marshy ground, and all the other cocoons produced veritable *A. palustris*, there could be no mistake, and, moreover, the identity of our description with that of Briggs leaves no room even for suspicion. We observe, too, that Briggs has a note on this point which we unhesitatingly confirm. He writes (*Trans. Ent. Soc. Lond.*, 1871, p. 438): "As the variation in the larva of *A. filipendulae* tends towards confluence, the variation here is towards obliteration, but the caterpillar is *very* constant, its range of variation very small. As the limit towards magnitude of the spots in this species is attained before the limit of *A. filipendulae* towards obliteration commences, it follows, as a matter of course, that I have never seen any tendency towards the X-like dorsal markings, or ever seen the lateral spots united." Comparing the larva of *A. palustris* with that of *A. filipendulae*, Briggs says: "Take a larva of *A. filipendulae*, give it a much clearer and cleaner ground colour, diminish its spots below the limits of the smaller spots in the larva of *A. filipendulae*, so as to make all the pale lines broader, and you will have a specimen of this caterpillar."

COMPARISON OF THE LARVÆ OF A. TRIFOLII VAR. SYRACUSIA AND A. TRIFOLII-PALUSTRIS.—Speyer compares these as follows: The larva of *A.* var. *syracusia* differs chiefly from that of *A.* subsp. *palustris* in the appearance and development of the upper row of spots. In the latter insect each segment carries two spots on either side, whereas in the former these are united into one large one which surrounds a patch of the ground colour. *A.* var. *syracusia* also has the front spot belonging to the lower rows lengthened into two points, a character not found in *A.* subsp. *palustris*; moreover, the latter does not have the black streak on the prolegs, whilst the other dark markings—the lateral streak, the longitudinal ventral line, and the markings on the anal plate—are much weaker, or are altogether absent. One can readily see that these differences, although so noticeable, are simply the result of the dark markings of the larva of *A. palustris* being more extended in that of *A.* var. *syracusia*, and that the latter has thus obtained only one large spot in the upper rows, where the former has two, the spots having joined at their extremities, so as to include a portion of the ground colour. The darkest larvæ of *A.* subsp. *palustris* are, of course, most like those of *A.* var. *syracusia*.

COCOON.—The cocoons measured, average 28-29 mm. in length. They are of a bright yellow colour, fusiform in shape, slightly broader at the upper end where the cocoon is also more brightly coloured, and attached to a grass culm or the stem of some low plant, usually some 12 inches or more above the ground. Sometimes it is flattened by being spun on the underside of a broad *Iris* (or other) leaf. The inside is lined with flossy white silk; the upper part of the cocoon is very thin, breaking easily to allow the emergence of the pupa, which pushes itself out of the cocoon as far as the 4th abdominal segment, before the emergence of the imago. The empty pupa-case remains projecting from the cocoon. Speyer notes the cocoon as somewhat smaller, and more swollen or vaulted than that of *A. fiilipendulae*, the upper half of a deep yellow colour, which shows up conspicuously against the almost white lower half in the majority of the cocoons, so much so that the difference is often apparent from some distance. In some it is less distinct, and in others the difference disappears altogether. Usually found on grass or *Juncus* stalks, or the stems of stiff herbaceous plants. [Those of the early *A. trifolii* are generally placed low down, on or near the ground, and are difficult to find.] Oberthür observes that when the wind moves the grass culms on which the cocoons are spun, the latter resemble very closely the flower-heads of the grass.

PUPA.—The pupa is uniformly black, with a prominent headpiece projecting beyond the prothorax; the thorax and the 1st and 2nd abdominal segments dorsally, also the wings, maxillæ, legs and antennæ, shiny black; the remaining abdominal segments duller blackish, but with shiny rings on the posterior portions of the segments, and a shiny cremaster. *Ventral view:* The mouth is ventral, surmounted by a prominent headpiece; the glazed eye forms a distinct lunule, running from the base of the antenna to the base of the first pair of legs; the maxillæ forming two slender ridges, extending to the 6th abdominal segment, passing for some distance beneath the first pair of legs and antennæ, but reappearing again at the 5th abdominal segment. The third pair of legs terminates on either side of the tip of the tongue. The antennæ terminate above the incision, between the 4th and 5th abdominal segments. The first pair of legs conspicuous, but the second pair almost entirely hidden; the terminal portions of the maxillæ and third pair of legs free from the abdominal segments; the ventral portions of the 6th, 7th and 8th abdominal segments exhibit transverse scars in the position of the larval prolegs. The genital organs, on the 9th abdominal segment, are not at all conspicuous; there are distinct divisions ventrally between abdominal segment 8, abdominal segment 9, and the cremaster, in the ♂ pupa, whilst in the ♀ pupa, the genital organs on abdominal segment 8 cause the partial obliteration of the division between 8 and 9. *Lateral view:* The antenna comes from the front of the head along the costa of the wing; the fore-wing itself shiny with distinct neuration, the hind-wing extending for some distance beyond the inner margin of the fore-wing; the spiracles on the 3rd, 4th, 5th, 6th and 7th abdominal segments consist of a slight oval depression, surrounded by an illdefined rim; above the spiracles on these segments is a deep oblique depression; on the 8th abdominal segment the spiracle is undeveloped; the cremaster is rounded, smooth and shiny; the abdominal incisions very distinct, dull black in colour. *Dorsal view:* The dorsal headpiece is prominent, extending beyond the prothorax, which is clearly defined; the mesothorax swollen dorsally, and extending laterally into the fore-wings; the central part of the metathorax narrow, wider at the sides where it extends into the hind-wings. The 1st, 2nd, 3rd, 4th and 5th abdominal segments moderately uniform in width, the succeeding segments gradually decreasing in size until the cremaster is reached. Each abdominal segment, after the first, consists of: (1) A dark intersegmental membrane. (2) A black transverse ridge. (3) A thinner pale band. (4) A line of longitudinal black ridges bearing series of prominent rough points (by which pupal movement is effected). (5) A shiny belt, fading back into the dark hinder part of the segment (and comprising the greater part thereof), and further into the intersegmental membrane. Movable incisions occur between abdominal segments 3-4, 4-5, 5-6, 6-7 in the female, also 7-8 in the male (probably also between 1-2, 2-3 in both sexes). The cremaster rounded, with a number of short black points. The anal segment seems to be formed by the fusion of the 9th and 10th abdominal segments. [Description made July 13th, 1897, from pupæ collected at Waxham, on the Norfolk coast, by Mr. Bacot.] Speyer notes the pupa as black, but the back of the abdomen of a somewhat paler colour, with green segmental incisions.

DEHISCENCE.—In dehiscence, the pro- and mesothorax split mediodorsally. The head, antennæ and tongue separate from the other appendages; the leg-cases disjointed from the base of the antennæ, and the latter from the wings.

PARASITES.—(1) *Cryptus ? zygaenarum*, Ratz., appears at the same time as the imago, emerging by a round hole near the front of the cocoon. (2) *Microgaster* ? sp., whose larvæ bore their way out of the half- or nearly full-grown larva of the host, and spin white silken cocoons, usually upon the body of the dying victim. (3) *Pteromalina* ? sp., which emerged through dorsum of the pupa and cocoon on July 31st. (4) A fat lemon-yellow coloured grub which lives in the larva and pupa, and probably does not mature until the next year (Speyer). *Blepharides vulgaris*, Fln., a dipterous parasite, was bred from *A. palustris*, from Rennes (Oberthür *teste* Austin).

FOOD-PLANTS.—The large trefoil found in marshes, and on that plant only (Briggs), *? Lotus uliginosus* (Speyer).

HABITAT.—This exceedingly local and gregarious subspecies appears to confine itself almost entirely to a distinctly marshy habitat. It may be a piece of real marsh, now isolated from the sea, as at Sandwich. It may be a swamp where a river takes its origin, and soaks the ground around, as at Freshwater (Isle of Wight), or it may be a marsh among the low coast sand-hills, wet enough in winter and spring, but fairly dry in summer, as at Waxham, in Norfolk. At Gamlingay it occurs in a disused brickfield, whilst near Ipswich it appears on marshy land. At Barmouth it occurs along the sides of the estuary of the Mawddach; at Hale, on a marsh, but on the roadside leading from there to Ditton; in a boggy meadow (now drained) between Carmarthen and St. Clear's, and always in wet places in the Isle of Purbeck. At Aldermaston it occurs in damp meadows between large ponds; near Dorchester, on a boggy common with much rush, bracken and alder, and at Tuddenham it occurs on a bog, the cocoons on rush, etc. In the Isle of Man it is found on the Ballaugh Curraghs, near Sulby, and near Worthing it finds a home in a heathy bog. At Sandown it occurs at the edge of the cliff and undercliff, on damp reedy ground, and also in a marshy meadow a little way inland. At Ippolytts Common, nr. Hitchin, Herts, in a small fen, the large form occurred in thousands, and flew all over the fen in the sunshine, giving a most distinct "pink appearance" to the landscape; Durrant notes that he has never elsewhere seen any species so abundant, nor produce such an effect. At King's Lynn it is sometimes very abundant in the corners of heaths (Atmore). In Herm it occurs on a sandy common on the coast (Luff). On the Continent, it is found on the marshy banks of the Weise and the Plöne, nr. Damm. Speyer says that in north-west Germany, its localities are, without exception, wet swampy meadows, in which it sometimes appears in immense numbers; it was especially common there in 1873, 1874 and 1875. Its most remarkable habitat, however, is that near Rennes, where Oberthür finds, in May and June, the cocoons on stems of grass, in an avenue of chestnut trees, and in the ridings of a wood about a league from the town. He finds it, however, in the marshes near the seaside, at Cancale, and in the Isles of Chausey, etc., in July and August.

TIME OF APPEARANCE.—It varies according to the season, but is rarely out before the commencement of July, except in the very earliest seasons. Its average time of emergence is, perhaps, from July 10th-20th, but in late seasons it runs well into August. Hodges notes that, at Freshwater, July 10th-12th may be considered the average date of emergence, but that larvæ are to be found spinning up after the first imagines have appeared, so that the insect is on the wing for a considerable time. Briggs says: "The time of appearance varies from the second week in June until the second week in July, according to the season, but always (in the same year) a month after the true *A. trifolii.*" In Pomerania, the larva is found in the beginning of June, the imago in July and August (Hering); whilst in north-west Germany, it first appears about the middle of June, and lasts from 4-6 weeks; in 1876, pupæ were first found on June 16th, larvæ as late as June 21st, and the first imago on June 28th (Speyer). The most remarkable date, for undoubted specimens of this usually larger and later insect, is the end of May and June, given by Oberthür, for Rennes, where it occurs in fields and the rides of woods, another proof of the connection between an early date and a comparatively dry habitat. Elsewhere, he says, it is generally common, and found on marshes near the sea, sometimes in great abundance, although at Cancale it is more rare. The following references probably refer to this insect: June 27th, 1864, at Tilgate; young larvæ, May 17th, 1866, imagines, July, at Stowe Wood, and July, 1871, at Wimbledon (T. Briggs), end of June, at West Horsley Park (Stephens *teste* T. Briggs), June 2nd-15th, 1856, at Bisterne (Oakley), July 19th, 1858, at Stonehaven (R. Thomson), July 6th-13th, 1864, at Freshwater, July 29th, 1889, July 5th-9th pupæ, emerged July 6th-27th 1891, at Sandwich (Fenn), June 16th, 1869, very early year, at Cirencester (Harman), July 31st, pupæ emerged till August 11th, 1874, at Herm (Luff), July 8th, 1877, at Henley, July 19th, 1889, at Butterwood, Odiham, July 4th, 1889, at Aldermaston, July 2nd, 1891, at Sulham (Holland), July 4th, 1878, at Barmouth (Sheldon), August 4th, 1880, at Oughton Common, July 7th, pupæ and larvæ, excl. July 9th-20th, pupæ June 21st, excl. July 2nd-11th, 1884, at Ippolytts Common (Durrant), imagines captured July 17th-18th, 1883, July 16th, 1887, imagines bred July 10th, 1886, July 29th-August 3rd, 1887, nr. Studland, and imagines bred June 29th-July 4th, 1893, from another locality nr. Studland (Bankes), July 18th, 1884, July 7th-16th, 1887, at Sandwich (Tutt), July 6th, 1885, at Upton St. Leonards (Higgs), July 3rd-14th, 1887, at Carmarthen, July 12th (♀s worn)-July 25th, 1890, July 11th-28th, 1891, June 29th-July 13th, 1892, June 1st-11th, 1893, early year, at Sketty Park, nr. Swansea (Robertson), end of July, 1887, July 27th, 1888, between Sandown and Shanklin, July 20th-23rd, 1896, July 17th, 1897, worn, nr. Sandown (Prout), August 20th, 1890, at Alum Bay (Raynor), July 4th, 1891, at Swanage (Bristowe), July 12th, 1891, at Aldermaston, July 8th-16th, 1892, June 16th, 1893, early year, common, June 15th-28th (two only on 15th, common on 28th), 1897, nr. Dorchester (J. Clarke), July 16th, 1891, July 16th, 1893, larvæ, pupæ and imagines abundant, at Gamlingay (Bond-Smith), end of July, 1892, at Porthcurnow, nr. the Land's End (Bowles), August 5th, 1892, at Swanage (Mackonochie), August 1st-3rd, 1892, also pupæ, August 6th-13th, 1894, also pupæ, at Swanage (Fox), July 6th-7th, 1893, early year, July 26th-27th, 1894, cocoons June 25th-26th, 1896, cocoons June 25th-26th, 1897, commenced to emerge July 13th, 1897, cocoons June 25th-26th, 1898, at Waxham (Bacot), July 10th, 1894, July 6th, 1895, pupæ June 27th, 1896, pupæ June 30th, 1897, imagines July 23rd, 1897, at Aylsham (Freeman), July 29th-August 1st, 1895, at Freshwater (Page), July 6th, 1896, at

Sheerness, common, worn (Bower), July 16th, 1896, in Ballaugh Curraghs (H. S. Clarke), July 7th, 1896, very common at Freshwater (Rothschild), June 30th-July 18th, 1897, at Amberley Bog (Fletcher), July 27th-August 2nd, 1898, at Sandown (Dadd), August 8th-15th, 1898, at King's Lynn (Atmore), July 14th, 1898, nr. Bovey Tracey (Hamm).

Localities.—The localities are difficult to separate from those of *A. trifolii*, lepidopterists having recorded their captures under the latter name, often without any hint as to what form reference is made. The following list is probably correct (though necessarily incomplete). Berks: Aldermaston (Clarke), Sulham (Holland), Reading (Hamm). Cambs: Gamlingay (Bond-Smith). Carmarthen: Carmarthen (Robertson). Cheshire: Bidston Marsh (Cooke), Malpas (Walker), Oakmere and Knutsford (Chappell). Devon: Bovey Tracey (Hamm), Lynton Marsh (South). Dorset: Purbeck, nr. Studland (Bankes), nr. Dorchester (Clarke), Swanage (Fox). Forfar: nr. Stonehaven (R. Thomson, wants confirmation). Glamorgan: Swansea (Robertson). Gloucester: Cirencester (Harman). Upton St. Leonards (Stanger-Higgs). Hants: Lyndhurst (Alderson), Basingstoke (Hamm), Bisterne (Oakley), Butterwood, Odiham (Hollaud). Isle of Man: nr. Sulby (Clarke). Isle of Wight: Sandown (Prout), Alum Bay (Raynor), Shanklin undercliff (Helps), Freshwater (Hodges). Kent: nr. Eltham (Stephens), Sandwich (Fenn), Sheerness (Bower). Lancashire: Hale, Ditton (Gregson). Merioneth: Barmouth (Sheldon). Norfolk: Waxham (Bacot), Aylsham (Freeman), King's Lynn (Atmore). Oxford: Henley (Hollaud), Stowe Wood (Briggs). Pembroke: Lougboro' Marsh nr. Tenby (Tutt coll.). Suffolk: Tuddenham, Bury St. Edmund's (Bloomfield), nr. Ipswich (Mera). Surrey: West Horsley Park (Stephens), Haslemere (Barrett). Sussex: Tilgate (Briggs), nr. Worthing (Fletcher). Warwickshire: Warwick (Adkin). Yorks: between Bridlington and Spurn (Boult), Richmond (coll. Tutt, captor unknown).

Distribution.—The distribution of this insect on the Continent is not known. The following references possibly belong to this late form:—France: Brittany, Rennes, Biarritz, Cancale, Îles Chausey, nr. Granville, Limoges, etc. (Oberthür). Germany: North-west Germany (Speyer), Pomerania (Hering), nr. Damm, nr. Finkenwald and Tantow, common (Hering). Netherlands: (see, *ante*, pp. 486 and 499).

ANTHROCERA FILIPENDULÆ, Linné.

Synonymy.—Species: *Filipendulae*, Linné, "Sys. Nat.," 10th Ed., no. 32, p. 494 (1758); 12th Ed., no. 34, p. 805 (1766); "Fauna Suec.," p. 290 (1761); Scop., "Ent. Carn.," p. 189 (1763); Hufn., "Berl. Mag.," ii., p. 186 (1766); Fab., "Sys. Ent.," no. 1, p. 550 (1775); "Spec. Ins.," pt. ii., p. 157 (1781); "Ent. Sys.," iii., pt. 1, p. 386 (1793); Schiff. and Den., "Sys. Verz.," p. 45 (1776); Müll., "Zool. Dan.," p. 116, in part (1776); Amstein, "Fuess. Mag. Ent.," pp. 109, 124, 299 (1778); Fuessly, "Mag. Ent.," i., p. 139, pl. i., fig. 2 (1778); Esp., "Schmett. Eur.," ii., p. 138, pl. xvi., figs. *a-e* (1780), p. 233, pl. xxxvi., fig. 8 (1783); Scheven, "Fuessly's Neues Mag.," i., p. 54 (1782); Schrank, "Fuessly's Neues Mag.," ii., p. 207 (in part) (1785); "Fauna Boica," ii., pt. 1, p. 239 (1801); Brahm, "Fuessly's Neues Mag.," iii., p. 152 (1786); Bork., "Sys. Besch.," ii., pp. 12, 160 (1789); "Rhein. Mag.," i., pp. 308, 630 (1793); Vieweg, "Tab. Verz.," p. 23 (1789); Hb., "Eur. Schmett.," p. 80, pl. v., fig. 31 (1797); "Verz.," p. 117 (? 1822); Haworth, "Lep. Brit.," p. 73 (1803); Ochs., "Die Schmett.," ii., p. 54 (1808); Godt., "Hist. Nat.," iii., p. 127, pl. xxii., fig. 2 (1821); Stephs., "Illus.," i., p. 110 (1828); Bdv., "Mon. des Zyg.," p. 59, pl. iv., fig. 1 (1829); Curt., "Brit, Ent.," xii., pl. 547 (1835); Wood, "Ind. Ent.," p. 11 (1839); Zell., "Isis," 1839, p. 274; Evers., "Fauna Lep. Volg.-Ural.," p. 96 (1844); Assmn., "Abbild. Besch. Schmett. Schles.," ii., p. 11 (1845); H.-Sch., "Sys. Bearb.," ii, p. 42 (1845); Kayser, "Deutsch. Schmett.," p. 175 (1852-9); Sta., "Man.," ii., p. 81 (1857); Speyer, "Geog. Verb. Schmett.," p. 348 (1858); Hein., "Schmett. Deutsch.," p. 163 (1859); Wallgrn., "Skand. Het.," p. 101 (1863); Lucas, "Hist. Nat.," 2nd Ed., p. 154 (1864); Snellen, "De Vlinders," p. 126 (1867); Nolck., "Lep. Fn. Estl.," i., p. 99 (1868); Newm., "Brit. Moths," p. 24 (? 1869); Staud., "Hor. Soc. Ent. Ross.," vii., p. 103 (1870, pubd. 1871); "Cat.," p. 47 (1871); Briggs, "Trans. Ent. Soc.

Lond.," p. 420 (1871) ; Mill., "Cat. Lép. Alp.-Mar.," p. 126 (1872) ; Curò, "Bull. Soc. Ent. Ital.," vii., p. 198 (1875) ; Frey, "Mitt. Schw. Ent. Ges.," iv., p. 225 (1874) ; "Lep. der Schweiz," p. 68 (1880) ; "Mitt. Schw. Ent. Ges.," vii., pp. 13-17 (1884) ; Kirby, "Eur. Butts.," etc., p. 91, pl. xxi., figs. 10, *a-b* (1879) ; "Cat. Lep. Het.," p. 70 (1892) ; "Handbook," etc., p. 94 (1897) ; Sand, "Cat. Lép. Auv.," p. 23 (1879) ; Fritsch, "Denks. Math. Nat. Cl. Akad. Wiss.," xli., pp. 62-3 (1879) ; Peyer., "Cat. Lép. Als.," 2nd Ed., p. 48 (1880) ; Schneider, "Tromsö Mus. Aarsheft.," iii., pp. 85-86 (1880) ; Christ, "Mitt. Sch. Ent. Ges.," vi. p. 45 (1880) ; Schöyen, "Norg. Ark. Lep.," p. 172 (1881) ; Selys-Long., "C. R. Ent. Soc. Belg.," p. cxiv (1882) ; Robs., "Young Nat.," iv., p. 161 (1883) ; Oberth., "Lép. des Pyr.," p. 31 (1884) ; "Var. chez Lép.," pp. 43-5 (1896) ; Buck., "Larvæ," etc., ii., p. 97, pl. xix., fig. 4 (1887) ; Hofmn., "Die Gross-Schmett.," p. 35 (1887) ; "Die Raupen," etc., p. 37 (1893) ; Auriv., "Nord. Fjär.," p. 53 (1888) ; Barr., "Lep. Brit.," ii., p. 133, pl. lx (1894) ; Meyr., "Handbook," etc., p. 447 (1895) ; Caradja, "Iris," viii., p. 73 (1895) ; Tutt, "Brit. Moths," p. 351 (1896) ; "Ent. Rec.," ix., pp. 88, 103 ; Reutti, "Lep. Bad.," 2nd Ed., p. 45 (1898). *Filipendula*, Poda, "Mus. Graec.," p. 82 (1761). *Aries*, Retz., "Gen. Sp. Ins.," p. 35 (1783).

Original description.—*Sphinx*. Alis superioribus cyaneis : punctis sex rubris ; inferioribus rubris immaculatis (Linné, *Systema Naturae*, 10th Ed., p. 494).

Imago.—Anterior wings 25-39 mm. in expanse ; bronzy-green (varying in depth) in colour ; six bright crimson spots, the 6th usually well-defined and separate from the 5th. Posterior wings crimson, with a narrow, dark, marginal band.

Sexual dimorphism.—The size variation in the two sexes is usually well marked, the males being distinctly smaller on the average than the females. A series of Hartlepool specimens gives the following measurements : ♂ s 25 mm.-34 mm., ♀ s 29·5 mm.-37·5 mm. ; from Deal, ♂ s 29·5 mm.-36 mm., ♀ s 31·5 mm.-39 mm. ; from Sligo, ♂ s 33 mm.-34·5 mm., ♀ s 34·5 mm.-37·5 mm. ; from Dover, 27·5 mm.-33·5 mm., ♀ s 33·5 mm.-38·5 mm. The sexual variation in colour in the specimens we have is comparatively slight, all the females in our possession being of a very distinct bronzy-green tint, the males being of a rather deeper hue ; a specimen of blue-green colour is apparently rare, and we have no British examples of a distinct purplish hue in a very long series. The males of the Alpine *ochsenheimeri* have frequently blue-green fore-wings, and the males of Fletcher's hybrid *ochsenheimeri* × *filipendulae* are also of a blue-green tint in a large proportion of specimens, whilst some Tyrolean examples of *ochsenheimeri* have quite purplish males, and even the females incline to the same tint. Blue-green males are not unusual in *A. hippocrepidis*, St., which seems to follow *A. trifolii* in its sexual variation. The males of *A. filipendulae* have, usually, a broader hind-marginal band to the hind-wings than the females.

Variation.—The forms of this insect that have almost attained specific rank (having independent life-cycles and habits), such as *ochsenheimeri*, Zell., and *hippocrepidis*, Stephs., are dealt with at length later. Apart from these races (or sub-species), however, *A. filipendulae* presents some marked tendencies to vary, not only in the arrangement of the normal red spots of the fore-wings, but also in their tint, the latter peculiarity being shared with the red hind-wings. Of its general variation in Scotland, Horne notes that he obtains *A. filipendulae* on the Kincardineshire coast, and that "examples with 5 + 6 confluent are not uncommon, and occasional individuals also have 3 + 4 united, but the latter are rare ; in one specimen 3 + 4 + 5 + 6 form a single blotch. All Kincardine examples have bluish-green fore-wings (not brassy-green, as observable in English specimens)," but Reid writes that all Scotch examples that he has seen "have the ground-colour of a greenish hue, and the red has a slight tinge of yellow, the spots not nearly so clearly defined as in most English examples, and 5 + 6 usually more or less united." Adkin records specimens from Sutherland, 2,000 ft. elevation, that are indistinguishable from Sussex examples, even the size being well up to the average. Kane records a small race as occurring in Monaghan in 1893, with very small red blotches on the fore-wings, and a tendency to confluence between 1-2, 3-4 and 5-6, and one may add here that, apart from the small race separately described as *hippocrepidis*, Stephs., some examples of otherwise typical *A. filipendulae* are very small, expanding sometimes only from 25-28 mm. (= ab. *minor*, n. ab.) ; they are usually taken with the type, have peculiarly narrow wings, and are undoubtedly a result of defective nutrition in the larval stage. Caradja says that in Roumania the specimens, generally, have the hind-wings more broadly margined with black than those of typical examples, whilst amongst the typical specimens a very small form with light green fore-wings occurs on dry ground. He adds that "just such a form, but with five spots, has been observed at Hermannstadt, in South Russia, and the Caucasus." Nolcken observes that the specimens from the Baltic provinces vary much in size, the colour of the fore-wings greenish or bluish, the border of the hind-wings variable in width. Snellen says that specimens from the coast dunes of Holland are larger (reaching to more than 42 mm.) than those from the inland provinces (reaching from 23-37 mm.), they also have more glossy fore-wings, and larger spots of somewhat more fiery carmine-red colour. Examples from the south of Limburg are peculiar in the almost blue ground colour of the fore-wings. Wallengren notes two aberrations as occurring in Scandinavia: (*a*) Anterior wings with yellow-green ground colour. (*b*) The spots on the fore-wings more or less confluent. In the southern Alps a race (or species) with spot 6 rather small and ill-developed in the male, known as *ochsenheimeri*, Zell., is found, attaining a considerable size in the warm southern valleys. This forms, in part, Staudinger's var. *dubia*, a 5-spotted species (*medicaginis*, Bdv., *ante*, p. 470) being erroneously combined therewith by this author to constitute the latter variety. Frey had specimens from Sicily, sent under the name *ochsenheimeri*, which were rather small, strikingly pale, but otherwise ordinary, *A. filipendulae*. The normal spotting in this species, consists of 6 separate red spots. It frequently happens, however, that one or more pairs are confluent, in some examples the outer pair (5 + 6), in others 3 + 4 or 1 + 2, whilst in many examples 1 + 2, 3 + 4 and 5 + 6 are united in pairs, so that the 6 spots form but 3 (= ab. *cytisi*, Hb.). The spots, however, occasionally unite longitudinally (*ante*, p. 425). Among these confluent forms we find certain very distinct types, of which the rarest is the union of 2 + 4, 3 + 5, these spots with 1 forming three wedge-shaped blotches, similar to those existing normally in *A. purpuralis*; this we call ab. *trivittata*, n. ab. We have one example with the left fore-wing of the *trivittata* form, the right normal. More frequently 2 + 3 + 4 unite to form a single blotch, leaving 1, 5 and 6 separate (= ab. *confluens*, Oberth.). Bayne notes one, from Sandwich, with 1 + 2 + 3 + 4 united, 5 and 6 being separate (= ab. *bipunctata*, Selys). Sometimes 3 + 4 + 5 + 6 form one blotch separate from 1 and 2 (= ab. *communimacula*, Selys), whilst in the most extreme forms 1 + 2 + 3 + 4 + 5 + 6 form a single irregular blotch (= ab. *conjuncta*, n. ab.); other intermediate stages also occur. Adkin notices the capture of a specimen at Folkestone, 1892, with 6 reduced to a mere dot; Hawes, two examples, bred from pupæ, obtained July, 1876, on the railway banks at Oakleigh Park, in both of which 3, 4 and 5 are absent, and 1 and 2 much contracted; whilst Battley obtained an example at Bere Regis with 3 reduced to a dot, and 6 distinctly bisected by a nervure. South notes an apparently apterous ♀ from a pupa obtained at Folkestone, and Chapman, one from Hereford, with the larval head (compare, *ante*, p. 428), the latter not having been successfully moulted at the pupal change (*Ent. Rec.*, iv., p. 242). With regard to the colour variation of this species, the most extreme form is of a clear yellow (= ab. *flava*, Robson), others are of a distinct orange hue (ab. *aurantia*, n. ab.), others, again, of a red, entirely different from the type, described as "terra-cotta," distinctly intermediate between the orange and the crimson forms (= ab. *intermedia*, n. ab.). Jagger records an example, from St. Ives, with one hind-wing orange, the other red; whilst Robson notices another with one hind-wing yellow, the other normally tinted. A form which suggests a pathological failure of pigment has the ordinary crimson, of a pale pinkish hue, often with a trace of yellow in it (= ab. *miniata*, n. ab.). Fish records an example from Birkenhead, in which the yellow is tinged with pink. Turner bred pale pink forms from pupæ obtained in 1888, at Reigate, and Skinner, bred examples from Caterham larvæ, in 1887, with pink instead of crimson. Webb breeds specimens, at Dover, showing gradations of pink in the colour of the hind-wings. Harwood obtains the most interesting examples of these intermediate forms, at Colchester, and we are indebted to him for specimens and information. He does not capture the purely yellow form (= ab. *flava*), but obtains the orange form (= ab. *aurantia*), the red form described by various writers as "salmon-red," or "terra-cotta" red (= ab. *intermedia*), and the type. He also obtains the paler, pinkish form, (= ab. *miniata*), which might be mistaken for a washed-out ab. *intermedia*, were not the examples in fine condition; almost every possible intermediate form between yellow and crimson can possibly be obtained. Most of the Colchester aberrations were taken in 1891 and 1892, the aberrant specimens emerging from the pupa later than the normally coloured ones, pink and orange forms in those years being not uncommon: in 1892, too, the greatest year for the aberrations, there were many dwarfs. which were otherwise fairly typical. In 1893, the species was almost entirely absent, in 1894 and 1895 it was rare, but in 1896 the species (and the aberrations) appeared to be recovering lost ground, whilst in 1897 the property changed hands, and has since been almost ruined entomologically. In 1891, the cocoons were found high up on the grass culms, and in exposed situations; in later years very few were so exposed, the majority being situated low down among the herbage. Robson says that at Hartlepool "the yellow form is pale honey colour, and although some of Harwood's examples might be called *flava*, others are of a quite fiery-orange hue; a dull pink form also occurs at Hartlepool, which is very distinct in character." The records of intermediate forms are rarely sufficiently definite for one to judge whether the true "orange" form (= ab. *aurantia*) is meant, or the fiery orange-red form (= ab. *intermedia*). Richardson says (*E.M.M.*, xxv., p. 290), that he has found the intermediate, almost orange forms, very uncommon. Oberthür notes that he has four examples of a rosy-orange colour, all from England. Jagger records the capture of an orange form in July, 1869, at St. Ives. Fish notes that the orange-red or brick-red form varies in tint at Birkenhead, some approaching the normal form, others being decidedly different from it. Adkin exhibited, at the meeting of the South London Ent. Society, on November 25th, 1892, examples showing colour gradations between red and yellow. Hodges notes that he found in South Devon, in August, 1898, five of the intermediate yellow form, similar to those sent out by Harwood. One can hardly imagine the real appearance of the insects, so badly defined (*Ent.*, vi., p. 363) by Forbes as being partly red and partly yellow. It may be well to notice here that Richardson obtained, at Cambridge, a red specimen with a tendency to yellow. The scales on this specimen were seen (under the microscope) to be of a pale brick-dust colour, fewer than usual, especially on the hind-wings, which, when viewed with the naked eye, appeared to be of a paler and browner tint than those of typical specimens. The latter, from the Cambridge chalk-pit, usually have here and there light brick-dust coloured scales among the bright red ones, but he states that he has not seen any yellow scales on red specimens, nor brick-dust coloured scales on yellow ones. Tugwell had a beautiful specimen, in which the yellow shades off through orange to the usual tint. Hodgkinson notes examples that are more orange than yellow. The rarest colour aberration probably is the one in which the red is changed to brown = ab. *chrysanthemi*, Bork.; forms approaching this are recorded from Swansea (Holland) and Paris (Oberthür). Pathological leucochroism also occurs, a failure of pigment sometimes resulting in aberrations similar to ab. *grisescens*, Oberth. The red of the hind-wings is frequently broken into by irregular patches of orange, some examples suggesting strongly a want of vitality in the larval stage, others being fairly normal in appearance, except for this peculiarity. The variation in the width of the marginal border of the hind-wings has occasionally attracted attention. Battley records, from Bere Regis, an example in which the border was extended so as to occupy almost the whole of the wing, whilst Cooper notes that, in North Devon, he obtained examples that exhibited a considerable range of variation in this direction.

α. ab. *cytisi*, Hb., "Eur. Schmett.," p. 81, fig. 26 (? 1797); Staud., "Cat.," p. 47 (1871); "Hor. Ent. Soc. Ross.," viii., p. 103 (1870, pubd. 1871); Frey, "Lep. der Schweiz," p. 68 (1880); Selys, "C. R. Soc. Ent. Belg.," p. cxiii (1882); Lampa, "Ent. Tids.," vi., p. 30 (1885); Hoffmn., "Die Gross-Schmett.," p. 35 (1887); Auriv., "Nord. Fjär.," p. 53 (1888); South, "Entom.," xxiv., p. 233 (1891); Caradja, "Iris," viii., p. 73 (1895); Reutti, "Lep. Bad.," 2nd Ed., p. 45 (1898). *? Loti*, Bork., "Sys. Besch.," ii., p. 28 (1789); Esp., "Die Schmett.," p. 224, pl. xxxv., fig. 1 (? 1789); Kirby, "Cat. Lep. Het.," p. 70 (1892).—No. 17. Geisskleeschwärmer, *Sphinx cytisi*. Sph. 26, mas. Glossy green-black; the fore-wings with six carmine-red spots united in pairs, the hind-wings, except on the outer margin, red. Habitat: Bavaria, Swabia, and probably the whole of Germany. Syn: *Sphinx loti*, Esp. (Hübner).

We strongly suspect that *loti*, Borkhausen and Esper, is the same insect as *cytisi*, Hübner, but no certainty on the point can be established. It is the *filipendulae* var. *b* of Dalman and Wallengren (in part), the latter diagnosing it as: "Alarum anticarum maculis aut per paria aut omnibus confluentibus," so that he also includes the ab. *conjuncta*. Staudinger diagnoses it as: "Maculis, in mac. 3 magnis confluentibus," and later notes that on the Parnassus and Veluchi specimens occur "not rarely, in which, not only the two outer, but also the two central, red spots are united, each pair forming a larger roundish spot, these only differ from *ramburii* in the different tint of red, which is lighter in the latter." The aberration appears to be generally distributed with the type in Britain and on the Continent, varying in different localities in the proportion it bears to the type, and being more abundant in some years than others. The following continental records have been noted (among many others): Belgium: nearly as common as the type (Selys). France: Cancale (Oberthür), June 21st, 1898, Le Havre (Dupont), Nohant (Sand), rather common in the Rheims dist., Berru, Sillery (Demaison). Germany: Freiburg, Lahr, Karlsruhe, Weinheim, singly (Reutti). Italy: with the type (Curò). Roumania: Several at Kloster Neamtz, Varatic, Grumazesti, Azuga (Caradja). Russia: rather common in the Baltic provinces (Nolcken). Scandinavia: rare (Aurivillius). Switzerland: singly at Bellinzona (Meisner), Zürich (Frey), Gadmenthal, more abundant on the Simplon, and on the turf-moors at Siselen (Rätzer).

β. ab. *confluens*, Oberth., "Études," etc., livr. xx., "Var. chez Lep.," p. 45, pl. viii., fig. 132 (1896).—This example illustrates the form in which confluence of the spots of the fore-wings occurs, 2 + 3 + 4 being united, 1, 5, 6 being separate; seven analogous examples from England. The confluence of the spots of the anterior wings commences at the base, and not at the extremity, whilst in *A. trifolii*, on the contrary, the confluence usually appears to commence at the apex rather than at the base. Confluent aberrations are much rarer in this species than in *A. trifolii* (Oberthür).

The aberrations with confluent spots are not common in the British Islands, but are taken occasionally with the type. Fletcher bred a long series of confluent forms during 1896 and 1897, from parents captured at Deal, that showed a tendency in this direction. After two years inbreeding, most of the progeny were more or less blotched, 22 examples sent to us from this stock exhibiting the following forms: ab. *cytisi* (1 + 2, 3 + 4, 5 + 6), ab. *confluens* (1, 2 + 3 + 4, 5, 6 or 1, 2 + 3 + 4, 5 + 6), ab. *proconfluens* (1, 2 + 3 + 4 + 5, 6), and ab. *quinquejuncta* (1, 2 + 3 + 4 + 5 + 6), being among the progeny. Webb notes the form (*confluens*) as occurring at Dover. South, one approaching this form from Folkestone with a projection from 2 towards 3 + 4. No doubt most collectors have occasionally taken this or the allied aberrations.

γ. ab. *bipunctata*, Selys, "C. R. Soc. Ent. Belg.," p. cxiv (1882).—The basal and median spots united by a band. The two posterior spots well separated, as in the type; only one example, captured at Longchamps-sur-Geer.

It occurs occasionally in the British Islands. Briggs records it from Folkestone.

δ. ab. *communimacula*, Selys, "Comptes R. Ent. Soc. Belg.," p. cxiv (1882).—The median and posterior spots large, confluent two by two, communicating, moreover, by a band running along the costa, and thus forming a single irregular blotch, but this blotch remains separated from the double basal spot by a very narrow space. This aberration is the opposite to the ab. *bipunctata*, and nearly represents that which exists in the ab. *minoides* of *A. trifolii*. Described from two examples (♂ and ♀) captured this year at Longchamps-sur-Geer, about June 20th (Selys).

ε. ab. *conjuncta*, n. ab.—The six red spots of the fore-wings united into one large longitudinal blotch. Found rarely with the type.

Hübner first figured (*Eur. Schmett.*, fig. 166) the form of this species in which 5 + 6 are joined to the central and basal spots, but in his figure, 2 is separated from 1 by a fine green nervure, the formula being 1 + 3 + 4 + 5 + 6 and 2. The figure represents a male, and the blotch is not quite symmetrical on both sides; 1 stretches along the costa, joining 3 which reaches costa, 3 is joined to 4 + 6, and 5 united to 6. Hind-wings with a rather wide marginal border. Oberthür notes that he has taken two specimens at Cancale with the spots confluent throughout , the whole length of the wing.

ζ. ab. *grisescens*, Oberth., "Etudes," etc., livr. xx., "Var. chez Lép.," p. 45, pl. viii., fig. 135 (1896).—The upper wings of a pale greyish-blue, the hind-wings of a very pale rose tint in place of the normal red colour. England (Oberthür).

The specimen appears to be, judging from the figure, a pathological aberration, little pigmented, having lost the rich depth of tint that characterises the type. Bouttell records the capture of a "pale form" at Leigh, Essex, in 1890, which may belong here.

η. ab. *flava*, Robson, "Young Nat.," v., p. 236 (1884); Oberth., "Var. chez Lép.," p. 43. pl. viii., fig. 133 (1896). *Cerinus*, Robs. and Gard., "List Brit. Lep.," p. 7 (? 1885) ; South, "Entom.," xxiv., p. 233 (1891) ; Robs., Ibid., p. 296. *Lutescens*, Ckll. "Entom.," xx., p. 151 (1887); Tutt, "Brit. Moths," p. 352 (1896); Smart, "Ent. Rec.," x., p. 227 (1898). *Citrinus*, Webb, "Ent. Record," i., p. 33 (1890).—The hind-wings, and spots on fore-wings yellow (Robson).

Oberthür makes (*Bull. Soc. Ent. France*, 1887, p. lxxvi) some brief remarks on certain yellow specimens of *A. filipendulae*, bought at the sale of Sheppard's collection—four belonged to a small race, and were rather specialised, their colour might be called "lutea" (? = *hippocrepidis*, Stephs.) ; three others were of a larger race, and of a clearer yellow tint that might be termed "flava." Madingley chalk-pit was the once famous locality for the yellow forms of this species, but even the type is now practically extinct there, about 20 years ago one collector took over 200 pupæ in one day, 60 of which produced the yellow form ; as the chalk-pit is quite a small one, this wholesale collecting no doubt exterminated the species there (Farren) ; six examples bred from cocoons collected near Cambridge, in 1876 (Bairstow). Richardson notes (*E.M.M.*, xxv., p. 290) that he collected about 700 pupæ from a chalk-pit near Cambridge, and bred five or six examples of the yellow aberration, the area over which the colony was spread being confined to the old chalk-pit. He further records the aberration as occurring on some of the downs at Winchester (July, 1874, etc.), and finds it very uniformly pale yellow in colour. He notes also its occurrence at Ridgeway, and on some hills at a short distance from Weymouth. The yellow aberration does not appear to occur at Worthing, for Fletcher, on one evening, collected 1,200 cocoons, but did not breed a single yellow one. The following records have been noticed :—Somewhat abundant at Winchester in 1868, again in 1872, also in some plenty July 14th, 1873, bred specimens in 1875, and again bred several in 1876 (Forbes) ; a cream-coloured one at Egg Buckland, nr. Plymouth (F. Briggs) ; one on the Laird Embankment, about two miles from Plymouth (*ante* 1873, T. R. Briggs), single specimens from Caterham, first week in August, 1871 (Wells), nr. Finchley, 1873 (Thomas), nr. Maidstone, July, 1873 (Elgar), one nr. Maidstone (Ponton), Cuxton (Walker), Folkestone (Anderson), Newbury (Sladen), one, bred, at Thorley, also occurs in the Sunderland district (Hodgkinson), Box

Hill (Cockerell), one emerged August 23rd, 1888, from pupa obtained August 6th, 1888, at Mudstone Bay, Brixham (James), not uncommon, three in 1878, and several since, caught and bred, at Hartlepool (Robson), yellow examples, bred July 2nd and 3rd, 1881, at Hartlepool (Dixon), Lyme Regis in 1890, breeds regularly every year (Battley, *Ent. Rec.*, v., p. 280), several at Compton Bay, Isle of Wight (Hodges), four, July, 1891, on the undercliff, Brooke, Isle of Wight (Abbott), several in 1886, taken in Kent (Sabine, *Proc. Sth. Lond. Ent. Soc.*, 1886, p. 61), six bred from July 25th-August 7th, from cocoons obtained at Wrotham, July 20th, 1898 (Smart). It does not appear to be recorded abroad, Oberthür has 15 examples, all British.

θ. ab. *chrysanthemi*, Bork., "Sys. Besch.," ii., p. 166, pl. i., fig. 1 (1789); "Rhein. Mag.," i., p. 647 (1793); Esp., "Die Schmett.," ii., pl. xxxvii., fig. 1 (1789), supp. p. 1 (? 1806); Hb., "Eur. Schmett.," ii., pl. iii., fig. 17 (1803); Ochs., "Die Schmett.," ii., pp. 56-58 (1808); Bdv., "Mon. des Zyg.," p. 59 (1829); H.-Sch., "Sys. Bearb.," ii., p. 42 (1845); Hein., "Schmett. Deutsch.," p. 163 (1859); Staud., "Cat.," p. 47 (1871); Hofmn., "Die Gross-Schmett.," p. 35 (1887); South, "Entom.," xxiv., p. 234 (1891); Kirby, "Cat. Lep. Het.," p. 70 (1892); Oberth., "Etudes," etc., livr. xxth, p. 43, pl. viii., fig. 134, transitus (1896).—*S. chrysanthemi*, der Wucherblumenschwärmer, der Schwarzfleck. Nigro-cyanea; alæ anticæ nigro-cyaneæ: maculis sex nigris; alæ posticæ nigro-fuscæ: limbo tenuissimo cyaneo. Of the size and shape of *S. filipendulae*. Its body is glossy steel-blue. The ground colour of the fore-wings varies between steel-blue and green, with six blackish spots arranged in pairs. The hind-wings are black-brown, and have a narrow steel-blue margin (Borkhausen).

Borkhausen obtained the aberration from Schneider, who took it in the neighbourhood of Stralsund several years in succession, but always with the common *A. filipendulae*. He named it *chrysanthemi*, because the spotted Burnets are fond of settling on the flowers of the class of plants to which the *Chrysanthemum* belongs. Esper's figure was also made from one of Schneider's insects. Esper quotes Borkhausen in his text, and there is no doubt that the latter's name is prior to Esper's figure. Staudinger diagnoses the form as: "Ab. maculis obfuscatis." Herrich-Schäffer describes it as having "the spots reddish coffee-brown." Oberthür has three transitional forms leading to ab. *chrysanthemi*, from Paris, etc., which have the spots and hind-wings pale brown, one of them being figured *Etudes*, xxth livr., fig. 134. Heinemann notes it from near Stettin. The following appear to be the only British records of this rare aberration: (1) The specimen has not a particle of red colour about it; the six spots on the fore-wings dark brown, almost approaching black, the hind-wings of a decided brown colour; the ground colour of the fore-wings and marginal border of the hind-wings much as usual. The specimen was bred by Mr. Leslie (St. Leonard's-on-Sea), in 1864, from a larva taken with others, from which typical specimens emerged (Cooper, *E.M.M.*, i., p. 143). (2) The fore-wings are of the usual dark green colour, the spots being black; the hind-wings are black, with a dark green margin. The insect measures 1″ 2‴, and the spots are rather small. Captured July 3rd, 1881, in Wyre Forest (Nowers, *Entomologist*, xv., p. 39). (3) The ground colour of anterior wings of the usual shiny greenish-black, as is also the border of the posterior wings; the spots and ground colour of posterior wings of a dull black hue, thus showing up very distinctly. Reared from pupæ gathered at Fleetwood, in 1888. Two of these black aberrations emerged one morning in July with about 20 of the ordinary form (Baxter, *Entom. Record*, i., p. 240). (4) The fore-wings of the usual bluish-green colour, but the six spots are all black instead of crimson, the hind-wings also black instead of crimson, with the usual bluish-black border. Captured on July 15th, 1890, nr. Rhinefield, in the New Forest, whilst crawling up a stem of grass (Goss, *Ent. Mo. Mag.*, xxvi., p. 247). (5) The fore-wings smoky-black, with green and rosy gloss showing; the six spots black, and apparently slightly raised; the hind-wings dull black, captured June 24th, 1892, in a field a few miles from Hastings, in which *A. filipendulae* was swarming (Bird, *Entom.*, xxv., p. 194). (6 and 7) Two specimens exhibited at meeting of Ent. Soc. of London, October 5th, 1892, one captured at Lancing, Sussex, by ? B. G. Rye, the other in August, at Riddlesdown, by Mr. M. Holmes. (8) A specimen approaching this form was taken in 1892, at Swansea, by Holland.

ι. var. *mannii*, Herrich-Schäffer, "Sys. Bearb.," vol. vi., p. 44, supp. figs., 109-110 (1851-2); Staud., "Cat.," p. 47 (1871); Curò, "Bull. Soc. Ent. Ital.," vii., p. 197 (1875); Frey, "Lep. der Schweiz," p. 68 (1880); Hofmn., "Die Gross-Schmett.," etc., p. 35 (1887); South, "Entom.," xxiv., p. 233 (1891); Kirby, "Cat. Lep. Het.," p. 70 (1892); *nec* Lampa, "Ent. Tids.," p. 30 (1885); *nec* Auriv., "Nord. Fjär.," p. 53 (1888).—*Z. mannii*, Nick. (supp. figs. 109-110), from Gross Glockner. Differs from its three nearest allies, *A. filipendulae*, *A. transalpina*, and *A. medicaginis*, by its much shorter, less pointed antennæ and somewhat blunter fore-wings; its scaling somewhat more transparent, colour duller, the red being especially more crimson than carmine, spots 3 and 4 stand very obliquely under one another, much more so than in *A. filipendulae* and *A. transalpina*, and nearer than in *A. medicaginis*, 6 is large, and stands as near to 5 as in *A. filipendulae*. On the underside a slight red shade is present, uniting the spots. It differs from *A. hippocrepidis* and *A. angelicae* in the much duller red, and the less dense character of the red shade on the underside of the fore-wings (Herrich-Schäffer).

In the "Synonymic Index" (published at the end of the work, vol. ii., p. 35), Herrich-Schäffer refers to *mannii* as a possible form of *A. filipendulae*. Frey says that *A. filipendulae* gradually changes to var. *mannii* in the mountains, transition forms occurring in the valleys of the Upper Engadine, from S. Moritz to the Maloja Pass, whilst in the higher alps it is the usual form, *e.g.*, it is so in the Stelvio, in the mts. near Zermatt (Frey), Gadmenthal (Rätzer); in Italian Alps above 2,000 mêtres (Curò). Staudinger diagnoses it as: "var. alpina, tenui squamata."

κ. var. *arctica*, Schneider, "Trom. Mus. Aarsh.," iii., pp. 85-86 (1880); Kirby, "Cat. Lep. Het.," p. 70 (1892). *Mannii*, Lampa, "Ent. Tids.," p. 30 (1885); Auriv., "Nord. Fjär.," p. 53 (1888).—In 1878, Gylche sent me examples of *A. filipendulae* from Grötö (68° N. lat.), others again, in 1879. This form, from the most northerly limit of the species yet known, deserves a special name, as it differs in a general way from southern examples. This race is more thinly-scaled, which makes quite fresh examples appear dull and worn against a light background, especially the red colour, which appears also somewhat paler than in southern specimens, the scales also appear to be more loosely attached. On the average it is smaller, more slenderly built, the fore-wings more blue than in *A. filipendulae*, and the red spots smaller (although in one example the spots are united, and the blue ground colour is practically confined to the margin). On the other hand, there appears to be no difference in the shape of the wings, antennæ, nor in the dark margin of the hind-wings, except that the latter is perhaps rather narrower than in the type form. The description of the Alpine var. *mannii*, H.-Sch., in Heinemann, does not agree with the Arctic form, although I, at first, thought it would. It would be interesting to have these side by side for comparison (Schneider).

λ. var. *ochsenheimeri*, Zell., "Isis," 1847, pp. 303-307; Staud., "Cat.," p. 47 (1871); Frey, "Lep. der Schweiz," p. 68 (1880); "Mitt. Sch. Ent. Ges.," vii., p. 17 (1887); Hofmn., "Die Gross-Schmett.," p. 35 (1887); "Kirby," Cat. Lep. Het.," p.

70 (1892); Tutt, "Proc. Sth. Lond. Ent. Soc.," pp. 111-113 (1895): "Ent. Rec.," ix., pp. 69, 87-88, 103, 166, 170-171 (1897); South, "Entom.," xxiv., p. 233, in part (1891), *nec* Boden, "Entom.," xviii., p. 317 (1885). *Transalpina*, Hb., "Eur. Schmett.," figs. 15 ♂, 19 ♀ (1803), Ochs., "Die Schmett.," p. 60 (1808); Bdv., "Mon. Zyg.," p. 83, pl. iv., fig. 3 (1829); "Icones." ii., p. 67, pl. liv., fig. 10 (1834); Dup., "Hist. Nat.," supp. ii., pl. vi., fig. 1 (1835); Speyer, "Geog. Verb. Schmett.," i., p. 462 (1858). *Filipendulae-major*, Esp., "Schmett. Eur.," pl. xli., fig. 4, p. 19 (1789).—*Zygaena* atra, alis anticis nigrocyaneis, maculis sex connatis rubris subtus confluentibus; posticis rubris margine sinuato cyaneo. Usually as large as *A. filipendulae*, sometimes considerably larger. The fore-wings broader, more rounded, but not so much so as in *A. medicaginis* (*i.e.*, Ochs. *nec* Bdv.) Head, thorax and abdomen greenish-black, the antennæ with fine brownish tips, the legs yellowish beneath. The fore-wings blackish-blue with a greenish lustre, concolorous fringes, the spots nearly equal in size, those of each pair so close together that they almost touch, the basal spots shorter than those of *A. filipendulae*; on the underside a red shade unites them, and makes them appear confluent. The hind-wings broader than those of *A. filipendulae* and less convex, the marginal border broader, and encroaching on the ground colour; in the ♀ narrower. Italy and southern France (Ochsenheimer).

We have here given Ochsenheimer's description, because Zeller distinctly refers the name *ochsenheimeri* to this description, although the striking character of a small 6th spot mentioned by the latter is not noticed by Ochsenheimer. After stating that several species had been distributed under the name of *transalpina*, *e.g.*, Hübner's figs. 15-16, Esper's pl. xli., fig. 4 (the description on p. 19 suggests a different species from the figure), and Ochsenheimer's insect (*Die Schmett.*, p. 60), Zeller names the latter *ochsenheimeri*, and states that his own examples agree so accurately with Ochsenheimer's description, that he unhesitatingly refers them there, and, as the name *transalpina* is not available, he re-names it *ochsenheimeri*. Zeller distinguishes *ochsenheimeri* from *medicaginis*, Ochs. (to which he refers *charon*, Bdv., *Mon. des Zyg.*, p. 65, pl. iv., fig. 4) by the following characters: (1) The deeper red which resembles that of *A. filipendulae*. (2) The less sharp definition of the larger (? outer) spots. (3) The less finely pointed tip of the thicker antennæ. He considers that *ochsenheimeri* cannot be *A. filipendulae*, to which, otherwise, he was inclined to refer it, because its wings are in general much shorter, the marginal border of the hind-wings (especially of the ♀) broader, and the red area on the underside of the fore-wings more limited and more densely scaled. He further notes it as variable in size, but rather larger than *A. filipendulae*, the antennæ with a thicker club, more coarse base, and a shorter tip, the outer joint of which is sometimes reddish. The ground colour of the male is usually very bright steel-blue, rarely with a stronger tendency to green, whilst in the female the opposite is the case. The spots of the fore-wings and the hind-wings are of the same colour as those of *A. filipendulae*, and the spots have also the same form, but the 6th spot is small, and the nervure that passes through it is more often of the ground colour than red, like the spot. The marginal border of the hind-wings in the male broader than in *A. filipendulae*, in the female it is narrower, and on several of the nervures runs finely inwards. On the underside of the fore-wings a red shade, variable in width and intensity, runs from the base to the outer pair of spots, the spots, however, being distinguishable. Zeller caught a male at Syracuse, on the heights of Epipolæ, on April 26th, and the first ♀ in a valley north-west of Epipolæ; other examples, worn, were taken at Syracuse, on May 10th, in a grassy hollow on scabious flowers, and odd specimens throughout May. One worn female was found paired with a male *A. erythrus*. On a flowery hill at Tolentino, on September 6th, he caught four very small males in moderately good condition, and on September 11th, at Ancona, near the sea, several very worn males, and one very fine female. These differ from the Sicilian examples only by their small size (♂ = 1″, ♀ = 1″ $1\frac{3}{4}$‴, against ♂ = 1″ 4‴, ♀ 1″ $6\frac{1}{2}$‴) and more pointed fore-wings. In two males the 6th spot is exceptionally small, and the blue very bright. These specimens, Zeller says, are "obviously a second generation of *ochsenheimeri*," and show that this insect varies in shape, etc.; he suspects that it is influenced by the soil and more northern climate, but thinks that the Italian examples are nearer typical *A. filipendulae* than the Sicilian, and adds that "so little is known of the latter species that one is unable to say that it does not go through transitions that lead up completely to the *ochsenheimeri* of the last-named locality." Esper's figure of *filipendulae-major* was drawn from examples received by Gerning from southern France. The two sexes, he says, "only differ in the prevalence of blue or green, and the larger size of the female. There appears to be no difference in the tint and position of the six red spots, but the hind-wings have a broader margin than in *A. filipendulae*." Esper was inclined to consider it distinct, owing to its constantly larger size, and the wider marginal border of the hind-wings. Palumbo and Tedaldi accept [*Nat. Sic.*, vii., pp. 154-155 (1888)] *ochsenheimeri* as a form of *A. filipendulae*, and describe it as "larger and redder than the type, met with by Bellier, Mann, Zeller and Kalchberg, in addition to the localities already mentioned, at Taormina, Favorita and Syracuse." Bellier notices that "in this variety the spots are placed as in *A. filipendulae*, but somewhat nearer to the costa, and constantly smaller." Mann notes that "the larvæ of *ochsenheimeri* (*filipendulae* var.) from Sicily, are not rare on *Onobrychis* at the end of April. The cocoon is long and white, with silky gloss. The moth appears in mid-June, the colour of the fore-wings steel-blue, densely scaled, the hind-wings deep red with a broad blue-black border and fringes, whilst *A. filipendulae* is steel-green, the hind-wings carmine-red with narrow black border." Staudinger diagnoses it as: "var. major, saturatius rubra," and gives its distribution as "Italy, southern France, southern Alpine valleys, Greece, ? Pontus." Frey notes it as "about as large as the type, sometimes larger, corresponding with the type in habits and the spots on the fore-wing, although the black marginal border of the hind-wing is broader; recorded from Bechburg (Stehlin), south side of Simplon, Crevola, etc. (Christ)." Later he remarks (*Mitt. Sch. Ent. Ges.*, vii., p. 17), that "the antennæ of the male are decidedly longer and perhaps more slender" (Zeller says they are "coarser"); he further considers *ochsenheimeri* to be not exclusively the southern form, as he has "received typical examples of *A. filipendulae* from Sicily." Hormuzaki notes the variety as occurring on the mountains of Bucovina. Christ remarks that hybrid mingling of *ochsenheimeri* and *A. lonicerae* may occur, but he does not believe the five-spotted *ochsenheimeri* to be hybrids. Evidently this is another instance of the mixing of *ochsenheimeri* and *medicaginis*, Bdv. (*vide* p. 470). Zapater records it in August from Teruel. Boisduval, who distinguished it from *A. filipendulae* by the broader marginal border to the hind-wings and by its larger size, noted it from Sicily, and the parts of Italy nearest Piedmont. Duponchel captured it very commonly near Rome. This variety (? species), with spot 6 ill-developed in the male, appears well distributed in all the warm Alpine valleys. Oberthür obtains it in the Pyrenees. We have captured it in abundance in Piedmont, Courmayeur, and the Tyrol (Mendel Pass). At Aix-les-Bains the form appears transitional, and we are unable to distinguish between many continental examples and occasional aberrations found in Britain with the type. Fletcher has crossed (*Ent. Rec.*, ix., pp. 69-70) *ochsenheimeri* from Courmayeur with *filipendulae* from Sussex, and found the progeny perfectly fertile *inter se*. Some of the hybrid males, however, showed very marked *ochsenheimeri* characters.

μ. var. *ramburii*, Led., "Wien. Ent. Monats.," v., pp. 151-152, pl. i., fig. 10 (May, 1861); H.-Sch., "Neu. Schmett.," iii., p. 32, figs. 161-162 (Jan., 1861, ? ante-dated); Staud., "Hor. Soc. Ent. Ross.," 1870, p. 103; "Cat.," p. 47 (1871); Hofmn., "Die Gross-Schmett.," p. 35 (1887); South, "Entom.," xxiv., p. 233 (1891); Kirby, "Cat. Lep. Het.," p. 71 (1892).—*A. ramburii* varies much, is somewhat smaller than ordinary examples of *A. filipendulae*, somewhat blunter-winged (Herrich-Schäffer's figures show this even better than Lederer's), like the alpine var. *mannii*, which it also resembles in its pale colour. The body and fore-wings steel-blue, the antennæ with narrow clubs, and a finer apex. Spots 3 and 4 are, as a rule, confluent, 5 and 6 united into an ill-defined blotch, formed as in *A. achilleae*, intersected by the darker nervure 5; the spots on the underside are united by a red shade. Hind-wings narrow, with a glassy transparent area, at the base of the inner median nervure. Aberrations occur which are remarkable for the greater or less intensity of the red tint, and for the difference in the arrangement of the spots. In one extreme the spots are all separate, 6 very weak or (in one specimen) wanting. In some specimens the basal and central, or even all the spots, are united by longitudinal streaks, whilst the extremes in the other direction have the whole wing-surface occupied by the red colour, but the most extreme aberrations in both directions are, relatively, rare. More than 100 specimens collected at Antioch (Lederer).

Lederer, in spite of the differences here enumerated, suspected that *ramburii* was only a local form of *A. filipendulae*, and the transparent area on the hind-wing, together with the general appearance of the insect, alone decided him to describe it as a species. Herrich-Schäffer describes specimens received from Lederer, and states that the difficulty of separating the insect from *A. filipendulae* becomes greater the more numerous the specimens actually examined. He considers it to be "as a rule, smaller than *A. filipendulae*, its ground colour darker, bluer, the red thicker, the scaling denser (on the underside the spots are connected by a rather strong red shade), the 6th spot scarcely noticeable, and never placed so far back towards the outer border as in *A. filipendulae*, so that, on the whole, both pairs of spots appear more approximated. In the form of the wings and width of margin on hind-wings no difference is observable. Of 19 examples compared there are only six females, one with entirely normal markings, another (fig. 162) with completely confluent spots both above and beneath; between these extremes, however, are a number of transitions in both sexes, in which, first of all, the 2nd and 3rd pairs of spots unite, and then longitudinal rays appear between these and the 1st pair. In one example, 5 is round and placed beside the extremely weak 6." Staudinger diagnoses it as: "Maculis 6 in mac. 3 magnis confluentibus et al. post. miniaceis, Syr.; Graec. (ab.)," and in the *Hor. Ent. Soc. Ross.*, viii., p. 103, notes examples from the Parnassus and Veluchi as "only differing from *ramburii* in the different tint of red, which is lighter in the latter," and he adds that "since little importance can be attached to difference in wing form, the lighter colour is insufficient to separate the two forms as species."

ν. var. *gurda*, Led., "Wien. Ent. Monats.," v., pp. 152-153, pl. i., fig. 9 (May, 1861); Staud., "Cat.," p. 47 (1871). *Mersina*, H.-Sch., "Neu. Schmett.," fig. 163 (January, 1861, ? ante-dated).—*Zygaena gurda* is to be separated from *A. filipendulae* by the strikingly long and narrow fore-wings, with prolonged apex and oblique margin, the hind-wings likewise with very pointed apex; the antennæ somewhat longer. Anterior wings steel-blue (the ♀ with a greenish gloss); the antennæ reach three-fourths along the costa, produced into a narrow club, but less pointed at the apex than in *A. filipendulae*; the spots of fore-wings and hind-wings not deep, but bright crimson-red, spot 2 rounded, 1 somewhat lengthened, 3 and 4 confluent, sharply cut off above and below, broadest above, concave on both sides, and placed obliquely. The hind-wings pale carmine, with a very narrow steel-blue margin, somewhat transparent at base. The spots on underside of fore-wings united by a red shade. Only 4 specimens from Mersin.

Herrich-Schäffer's name is possibly subsequent to, although his book is dated previously to, Lederer's description. He describes five ♂s and one ♀ received from Lederer. He notices it as being on the average larger than *ramburii*, with noticeably narrower and more pointed wings, hardly broadened posteriorly, the red more transparent, approaching rose colour, the spots placed as in *ramburii*, but larger, always united in pairs, 3 extended towards the costa, and towards the base, whilst in *ramburii* it is always smaller than 4. Prout notes that Herrich-Schäffer's figures of *ramburii* have (fig. 161) 1 + 2 united, 3 + 4 separate but adjacent, with 3 slightly smaller, 5 + 6 separate but adjacent, with 5 larger; (fig. 162) 3 + 4 + 5 + 6 forming a shapeless blotch, 1 + 2 connected therewith by a tolerably wide longitudinal line, 1 continued wedge-like along costa, and not reaching quite to 3. His figure of *mersina* (*gurda*) (fig. 163) has longer and narrower wings, more slender body, spots in pairs as described, 1 running as a wedge to meet 3, which is elongate. There is not the remotest doubt from the figures that *gurda*, Led., and *mersina*, H.-Sch., are strict synonyms. Staudinger writes (*Hor. Ent. Soc. Ross.*, xiv., p. 321): "Lederer's *gurda* was described by him from four specimens from Mersin. At the same time he erected, from a large number of examples taken at the not far distant Antioch, a species which he named *ramburii*. Of this latter, 20 specimens, differing in an extraordinary manner from each other, stood in his collection; almost all are somewhat smaller than German *A. filipendulae*, with pale red hind-wings, and only in two large examples are they full carmine-red. These specimens scarcely differ from ab. *cytisi*. Lederer had also placed among his *ramburii* four specimens from Bosz-dagh (near Magnesia), which I can distinguish no better from *A. filipendulae* and its ab. *cytisi*, and in any case should not consider it to be var. *ramburii*. It is clear that Lederer was later of opinion that all were referable to *filipendulae* as varieties, *vide*, *Ann. Ent. Soc. Belg.*, ix., p. 59, where he states that *filipendulae* was found in the Bosz-dagh in all transitions to *ramburii*. His *gurda* from Mersin are, however, quite indistinguishable from *ramburii*, with pale reddish hind-wings. Lederer separates *gurda* from *A. filipendulae* principally by the 'peculiar shape of the wing' and by the 'different antennal form,' quite untenable and even unsafe differences, *e.g.*, the wing-shape varies so much in *A. achilleae* males, caught at Amasia, that one would rather separate the latter from the type form. I am compelled, therefore, to consider *gurda* as a synonym of *ramburii*. Haberhauer brought a typical, but small, *ramburii*, from the Taurus, among his *A. graslini*."

ξ. var. *laphria*, Frr., "Neu. Beitr.," vi., p. 135, pl. 568, fig. 2 (1850); H.-Sch., "Sys. Bearb.," vi., p. 44 (1852), fig. 108 (as *laphira*) (1851); Staud., "Hor. Soc. Ent. Ross.," xiv., pp. 320-321 (1878-9).—The red spots on the fore-wings are very large and irregularly confluent, so that they form only three larger spots of longish quadrate outline. The antennæ are very fine, with larger clubs. The abdomen slender and not at all thick. The underside similar to the upper, only somewhat paler. From the Caucasus, captured by Kindermann (Freyer).

Prout notes that Freyer's figure brings out all these points, and shows a moderately broad marginal border to the hind-wings; spot 4 is much larger than 3, 6 is small, and forms an elongate appendix to 5. Herrich-Schäffer's figure is more like normal *A. filipendulae* in appearance, the antennæ less markedly slender, spots 1 and 2, and 3 and 4 separate (3 intersected by a green nervure), 5 and 6 confluent, 6 smaller than 5, and united thereto. Herrich-Schäffer writes: "*Laphria*, Kind., Sppl. 108. Two males received from Amasia, through Lederer, of the form of a large *A. filipendulae*. Ground colour very dark, more blue than green, with an especially clear blue border to the hind-wings; the red as in *A. filipendulae*, spots 3 and 4 more obliquely placed, more extended longitudinally, 4 quadrangular, 5 and 6 united. Beneath, the red shade of the fore-wings is somewhat denser. The second example has a rather more convex margin to the fore-wings, and the spots (except 3) are somewhat larger. Staudinger notes (*Hor. Soc. Ent. Ross.*, xiv., pp. 320-321) as follows: "On July 5th, I caught behind the Jenikeui plateau, a ♂ which I certainly consider to be ab. *cytisi*. On July 12th-14th, I caught, on the Ak Dagh, at about the same elevation, three ♀s which I could only refer to *A. filipendulae* as a variety, and which almost exactly agree with the *laphria* of Lederer's collection. Kindermann sent specimens from Tokat which Lederer gives as *laphria*. The latter had in his collection examples (unfortunately without indication of locality) some of which may be from Tokat, others from Armenia. These specimens vary *inter se*, are of the size of small *A. filipendulae* or large *A. meliloti*, are mostly of a paler red than *A. filipendulae*, and have a broader black outer margin to the hind-wings, perhaps, than has *A. charon*. I at first thought that they were large aberrant *A. charon*, but now decidedly consider them to be a var. of *A. filipendulae*. In Gruner's collection there were also two examples from Kindermann, taken in Pontus, which stood as *laphiria*. The *laphira* (*laphria* in the text) figured by Herrich-Schäffer (fig. 108), came from Amasia, and appears to me to be only *A. filipendulae* ab. *cytisi*. The very peculiar-looking figure of *laphria* in Freyer, from the Caucasus, may also very well only represent an aberration of *A. filipendulae*.

Ovum.—The eggs are laid in masses, with some signs of regularity observable in the lower layers, but the upper layers are more irregular. The egg is pale yellow in colour, with one pole transparent, becoming darker yellow as the embryo matures. Length ·75 mm., breadth ·56 mm., height ·5 mm. It is somewhat oval in outline with blunt ends, tending to be brick-shaped. The surface is very shiny and covered with faint and shallow pittings. The empty shell is perfectly transparent (Bacot). Watkins describes the egg as oval, glassy, light orange in colour, the yelk only partially filling the egg. Hellins notes it is as being "very much like that of *A. trifolii*, perhaps a trifle shorter and stouter." Our own notes read as follows:—"If deposited in one layer, usually placed regularly and in 'contact,' but often as many as two or three tiers are laid above the basal one, and the eggs become at last placed very irregularly. Eggs laid July 24th, 1898, by ♀ taken at Aix-les-Bains, began to hatch August 7th. About three days before hatching they became dark coloured. Under a lens, this darkening is seen to be due to the dark heads of the larvæ showing through the transparent shell, the embryo being distinctly bent back in the form of a letter U inside the shell. The body of the unhatched larva is yellowish, but the dark heads quite overwhelm the rest of the colour of the larval embryos when viewed in mass. The full-grown embryonic larva is small, and occupies only about a third of the space within the shell. This suggests that the transparent pole of the egg is really devoid of yelk." Hofmann figures the egg with a well-marked polygonal reticulation.

Larva.—Bacot says that he observes no difference between the *newly-hatched* larvæ of *A. palustris*, *A. lonicerae*, *A. viciae* and *A. filipendulae*. The structure appears to be the same, and the arrangement and position of the tubercles are identical. The description of *A. lonicerae* in its first instar, therefore, practically applies (so far as structure and the arrangement of the tubercles are concerned) to all these species. When the larva has reached the hybernating stage, in its *third instar*, it is of a pale yellowish or creamy colour, with complex tubercular warts. *Dorsal view:* The head is retractile, placed ventrally, the prothorax hidden by the mesothorax. The abdominal segments are shiny, whitish, glassy in appearance, and separated from each other by distinctly yellowish segmental incisions. The central area is without tubercles, a broad longitudinal band of the pale ground colour extending from the mesothorax to the anal segment. On either side of this, but not distinctly raised above the segment, is a wart, clearly divisible into an anterior and posterior portion, each with five black tubercular points, forming a circle, with one similar one placed centrally; each point bears a long, yellowish, finely branched hair, with a dark tip, the central one distinctly stouter. In the front part of each segment, reaching to the segmental incision, and opposite the outer and posterior half of the large dorsal tubercle, is a small roughly quadrangular blackish patch, and a shade, slightly darker than the ground colour, unites these so as to give the idea of a faint longitudinal line; pale longitudinal bands of the ground colour separate the dorsal and supraspiracular warts, the latter of which, as well as the projecting subspiraculars, can be seen in a dorsal view. The projecting, black, tubular-looking spiracles on abdominal segments 1-2 are very conspicuous. *Lateral view:* The ground colour is distinctly yellowish or cream-colour. The prothorax is, however, glassy-looking, and the raised supraspiracular parts are also pale and glassy-looking; each of the latter carries ten black tubercular points (the central one very large), each bearing a similar hair to those of the dorsal warts, but paler. The prothoracic spiracle and the eight abdominal spiracles are jet black, each consisting of a projecting tube-like structure, placed on a little whitish cushion, and exceedingly conspicuous. The subspiracular warts are very striking in this species, consisting of a ring of six red-brown tubercular points, placed in the form of an almost complete circle, with a larger central one, two similar minute but separate points being placed directly below the lower edge of the circle; each point bears a glassy white minutely branched hair. There are two rows of marginal warts, the lower one running along the base of the prolegs, the other between the subspiracular and the lower row, each wart (both in the upper and lower rows) consisting of six outer red-brown points, arranged circularly, and one central one, each point bearing a white glassy-looking hair. *Ventral view:* The prothorax has the dorsal warts united, these bear white glassy-looking hairs, not yellow ones. The ventral area is yellowish, the prolegs of a paler whitish-yellow tint, bearing an inner curved flange with eight short black hooks on its edge. The true legs are of a similar colour, each bearing an exceedingly minute blackish terminal hook. The *adult* larva is of a pale yellowish colour, rather cylindrical in shape, although increasing gradually in size to the 7th abdominal segment. The terminal segments are much contracted ventrally, and hence slope very rapidly to anus. *Dorsally:* The head is invisible, being quite retractile within the prothorax, which forms a projecting hood with the tubercular warts united. The anterior and posterior trapezoidals (i and ii) are very readily distinguishable on the meso- and metathorax, and on the abdominal segments; the anterior, forming a circular raised wart or cushion with seven or eight dark tubercular points, each bearing a whitish hair, is placed between the dorsal ends of the two black spots on either side of each segment, the posterior, forming another similar but larger circular raised cushion, with 12 tubercular points, is placed between the lateral ends of the same black spots. These two cushions are united medially, forming, as it were, one long, somewhat oblique, wart, separating the anterior and posterior portions of the dorsal black markings on each segment; those on the metathorax are the least developed; they are even well developed on the anal (10th abdominal) segment. *Laterally:* The supraspiracular wart forms a large prominent cushion, carrying several (15-20) hair-bearing tubercular points, the hairs whitish, extending obliquely from the upper and anterior end of the segment, to the posterior part. This also separates two black markings, of which the anterior is the larger, and runs below the tubercle, sometimes including the spiracle, or it may be even joined at its lower extremity to the posterior mark. The subspiracular wart forms a raised cushion, carrying many hair-bearing tubercular points, with a black longitudinal mark below the wart, and none above. The marginal warts are directly below this black mark, somewhat smaller, quite round, and less prominent, but edged laterally and below by a conspicuous horse-shoe mark on the metathorax and 1st and 2nd abdominal segments, with an oval mark on the 3rd, 4th and 5th abdominal segments, and united with the subspiracular wart on the following segments. The spiracles in the specimens examined (preserved in spirit by Mr. South) are deeply embedded just below the supraspiracular tubercle, placed almost centrally in the segment, black in colour, with a black rim. This appearance is remarkable, considering the prominent condition of the spiracles in the hybernating stage of the larva. The prothoracic spiracle is more conspicuous, and placed well back, almost in the incision between the pro- and mesothorax. *Ventrally:* The head is withdrawn into the prothorax, and is shiny, black, with scattered pale hairs; some of the mouthparts white; ocelli shiny, black. The true legs of the pale ground colour, but with a red-brown chitinous plate on the outside of each joint, and with a sharp, curved, minute terminal point; the anterior edge of the base of the true legs and the upper joint is edged with deep black. The 1st and 2nd abdominal segments with very conspicuous, round, cushion-like warts, bearing many tubercular points, each with a fine hair. The prolegs are also of the same pale ground colour, the inner edge of the terminal joint spread out fan-like, and covered with short black hooks on the edge of the rim; a remarkable series of large warts, of the same nature as the lateral warts, is placed upon the upper joint of the prolegs externally, and appears to be a real lateral wart (the marginal); the inner surface of the prolegs is covered with raised golden points; a dusky, broken, medioventral line is more distinct on abdominal segments 1-4. Briggs describes the *full-grown* larva as having the head and true legs black, the head, with the transverse upper lip and the membrane at the base of the antennæ white; the ground colour greenish-yellow, arranged in a dorsal line, and two lines on each side; the dorsal line with a brighter yellow spot in the fold, formed by the hind-margin of each segment, the dorsal line much narrower on the thoracic segments. On each side of the dorsal line is a row of large black spots, two on each segment, of which the anterior is the larger, with the inner posterior angle emarginate, and rounded on the side nearest the head; the posterior spot is narrow and curved on the inner margin. The pro- and mesothoracic segments often have the anterior margin narrowly blackish, or partially margined with black, with the dorsal spots confluent, and the anterior greatly reduced in size. Below the dorsal longitudinal line of black spots is another longitudinal row of black spots, two on each segment, of which the posterior is nearly spherical, and the anterior larger and curved backwards, so as to terminate below the spherical spot, but sometimes uniting with it on the posterior segments. The lower portion of this curved spot, in which the spiracles are placed, is often separated from the rest, as in the larva of *A. palustris* (*trifolii-major*). A minute spot is often placed below the posterior of these two spots, but is as often obsolete. A longitudinal pale subspiracular line follows this row of spots, and between this line and the prolegs is a curved blackish line on each segment, bearing a pale transverse lunule in its lower portion. A slight dusky line is at the base of the prolegs. The prolegs and ventral area are pale, with an interrupted (often almost obsolete), medioventral, dusky line. Hellins describes the *full-grown* larva as being about 19 mm. long when at rest (but with considerable individual variation in size), and 7 mm. wide at the 5th abdominal segment. The latter is the largest segment of the body, which narrows gradually to the anal segment, and rather less so towards the head. The head is retractile within the prothorax, the segmental divisions well-marked; on each segment is a transverse row of eight raised warts, the two trapezoidal tubercles on each side of the back being united into an elongated wart, something like a dumb-bell in shape. All the warts are set with short hairs, the skin outside is full of little points. The general colour is dull greenish; all the warts are so coloured, and, by their interference, cut up the black markings; the dorsal line is yellowish-green, but bears a yellow spot at the hinder end of each segment. On either side of this comes what would be a black velvety stripe, except that it is cut up by the transverse warts into a row of black spots, so that on each segment there is a bigger blotch in front and a smaller one behind the wart. When the folds are contracted the hinder blotch on each segment coalesces with the front one on the next, so as to make one irregular blotch. Below this row comes a subdorsal line of the ground colour, bearing nine spots of deep yellow, placed on the hinder edge of the mesothorax and eight following segments. On this line commences the upper end of a longitudinal row of large oval warts, the lower ends of which intrude into a series of black spots, hollowing them out into a half-moon shape. On the lower edge of these black marks come the black, indistinct, spiracles. Below, again, comes a row of long oval warts, with their longer axes running longitudinally, and their lower sides edged with black, and then another row of small warts also set in black half-moons. The ventral prolegs have triangular warts on their sides. The head and thoracic legs are black. The short hairs on the warts are mostly whitish, but some are black.

VARIATION OF LARVA.—Briggs says that the larva has a great range of variation; its limit towards the confluence of the black spots is complete confluency. The angles then become developed, and assume the X-like appearance of the "early" *trifolii*, but the ground colour is always more dusky. The limit the other way, towards the obliteration of the black spots, is seldom beyond that in the description (quoted). In some thousands examined, this observer remarks that he has never seen one with the spots so small, and consequently the dorsal line so broad, as in the "late" *trifolii*, and he has never seen the spots in the shape of those of *A. lonicerae.*

COCOON.—The cocoons vary in size, but are about 25 mm. in length and 6 mm. in width, each tapering at either end to the diameter of the object to which it is attached, somewhat spindle-shaped, with a more convex curve at the apex than towards the base. It is papery and gummy (rather than silken) in texture, as shown by its being brittle, and by its rustling when handled, semitransparent (the blackish pupa visible through it), yellowish-white in colour, the reflected light giving it a shiny appearance. The silken threads run chiefly in a longitudinal direction, so that, although there is no worked opening, a longitudinal splitting readily takes place on emergence. The interior of the cocoon is rather more silky and less papery than the exterior. The usual colour is pale yellowish, and has a distinct trace, in many instances, of the paler basal half that is so pronounced in some species, others, again, are quite whitish in colour, whilst others are of a dark yellow tint. It is attached by its full length, the silk at the back usually encircling an ordinary grass culm completely, and does not go beyond the end of the cocoon; on a thicker stem this foundation may only extend half-way round, and on a flat surface a thin superficial layer alone is woven for the attachment of the cocoon proper. After the exit of the imago the empty pupa-case remains protruding from the ruptured end of the cocoon. Harrison notes that there is no loose silk in the cocoon, the whole being varnished until it has assumed the characteristic papery texture; his measurements of examples, taken in the Cher-et-Loir, exceed ours slightly, being 28 mm. long and 8 mm. wide. The cocoons are spun in a variety of situations—grass-culms, leaves of thistles, stiff stems of herbaceous plants, etc. Arkle notes them as being somewhat gregarious on stones at Tan-y-Bwlch, sometimes a dozen together; one often sees two or more on a single grass-culm.

PUPA.—♂. Length about 16 mm., breadth at 4th abdominal segment (widest part) nearly 5 mm. It tapers much towards anus (the abdomen being rather long and pointed) slightly towards head. The eye-covers, bases of antennæ and face piece (a ventral plate) project noticeably. The sexual organs well-marked. The abdominal segments 3-7 are free (probably also 1 and 2); the wing-cases are soldered (but not firmly) together and to appendages; the ends of the 3rd pair of legs and maxillæ project unattached from beneath the wings and reach the 6th abdominal segment; the antennæ are long, reaching with the wings just beyond the 4th abdominal; a small portion of the hind-wings extend beyond the fore-wings over the 1st and 2nd abdominal segments. The abdominal segments are dull or dead black in colour, the wings, thoracic segments and anus, shiny, the intersegmental areas between abdominal segments 2-8 are paler, but show best between 4-5, 5-6, 6-7, 7-8. Above and behind the spiracles, on abdominal segments 1-7, is a hollow, with the chitin in radiated folds (as though the end of a finger had been plunged, with a twisting movement, into putty or dough), and below the spiracle there is a hollow, less organically marked. These place the spiracles on a slightly marked and rounded lateral flange (the same structure, no doubt, that is so marked in Adscitids, and give these pupæ so flattened an appearance). On the dorsal anterior edge of abdominal segments 3-9 there is a ridge or row of strong curved hooks pointing backwards, and on the posterior edge of abdominal segments 6-7, a few minute spicules, or bristles, can be traced (they could hardly be called a row, as in the Psychids). The 9th segment has the usual row of hooks, somewhat modified, and a few nodules along its hind margin; the 10th bears somewhat dorsally some blunt points, about a dozen on each side, rather irregularly grouped, but capable of being regarded as a double or treble row. There is a slight tendency to a dorsal constriction or waist between the thoracic and abdominal segments. Of the head-parts the eye-covers and labrum are prominent, the base of the maxillæ has a projection that probably represents the maxillary palp, and there is an internal chitinous piece that may represent a further portion; other small and obscure pieces probably represent the mandibles. Bacot remarks that, having examined a number of pupæ collected within a few square yards, at Sandown, in August, 1898, he found the same difference with regard to the development of the anal spines as exists in the pupæ of *A. trifolii*, some of the pupæ of *A. filipendulae* having then quite as well developed as those of the latter species. Hellins describes the pupa as being "about 16 mm. long, cylindrical, of even bulk, except that the headpiece slopes rapidly from the back and stands out distinctly, and the last three segments of the abdomen taper. The antennæ-cases are strongly formed and well-developed, free at their tips, as is also the tongue-case, for some distance, and the edges of the wing-cases; the anal segment ends in a somewhat rounded boss, without a spike, but bearing some short sharp points, reaching to the spiracles and pointing backwards. The colour is glossy black on the head, thorax, wing-cases and tail; the abdomen is more dingy black, with the segmental folds showing dingy greenish." Moore notes (*Ent. Rec.*, iii., p. 37) a pupa found at Deal, in August, 1890, which was alive after a lapse of 17 months.

DEHISCENCE.—On dehiscence, the head, eyepieces and antennæ form one piece. The dorsal headpiece does not carry the eyepiece, which is attached to the prothorax. The legs separate very irregularly, but all the parts remain attached together by the internal dissepiments; even the thoracic coverings separate, to some extent, by the stretching of the intersegmental membranes. The spiracles are partially closed by very fine dendritic processes surrounding the orifice.

FOOD-PLANTS.—*Trifolium medicago*, *Lotus corniculatus*. [Also reputed to feed on *Spiraea filipendula* (Linné), *Plantago*, *Taraxacum*, *Veronica*, *Hieracium pilosella*, *Briza media* (Kaltenbach), *Leontodon*, *Hypericum* (Snellen).]

PARASITES.—*Campoplex decipiens*, Gr., *Cryptus filipendulae*, Bore, *Cryptus fumipennis*, Gr. (Perkins), *Mestostenus obnoxius*, Gr. (Bennett, Bignell, etc.), *Hemiteles furcatus*, Tasch. (Bignell), *H. fulvipes*, Gr. (Bignell), *Anomalon tenuitarsum*, Gr. (Weston), *Rhogas bicolor*, Spin. (Jenkins), *Apanteles zygaenarum*, Marsh. (July 21st, 1885, Bignell), *A. difficilis*, Nees von Esenbeck (July 21st, 1885, Bignell), *A. juniperatae* (Bignell), *Macrocentrus linearis*, Hal. = *M. abdominalis*, Fall. (Bignell), *Exorista vulgaris*, Fall. (Bignell), and *Tachina larvarum*, Linné (Bignell). Besides these, *Hemimachus instabilis*, Först. = *H. rufocinctus*, Gr. (bred July 10th, 1885, Bignell), and *Pezomachus analis*, Först. (Grigg), have been bred as hyperparasites upon *Apanteles zygaenarum*. The cocoons of *Mestostenus obnoxius* are found within the cocoons of *Anthrocera filipendulae* in winter, the imagines emerge during the last week of May or first week in June, one parasite only to each cocoon (Watkins); the imago of *M. obnoxius* does not appear until the larvæ of *A. filipendulae* are nearly mature, emerging from June 19th-July 3rd (Bignell). These two observations give a period extending from May to July for the emergence of this parasite. Anthrocerid cocoons, said to contain living pupæ that go over the winter, have probably been parasitised by this or an allied species.

HABITS AND HABITAT.—This species appears to be able to accommodate itself to almost every possible kind of habitat. Waste ground, hillsides, downs, sloping cliffs near the sea, coast sandhills, marshes, and even fenland are recorded as its haunts in Britain. It has the widest distribution of all our British species in these islands, extending from Sutherland to Cornwall, and the extreme west of Ireland, and appears to be more or less abundant in most of our English and Irish counties, less so, however, in Scotland. Sometimes one slope of a hill will produce the species more abundantly than another, *e.g.*, on the south escarpment of the chalk-hills, at Guildford, the species abounds, whilst on the other slopes it is comparatively rare (Grover); the stretches of shingle on the Sussex coast are a favourite haunt (Fletcher), whilst the marshy sides of the ditches scattered over the sandhills near Deal produce it in abundance (Tutt). Hodgkinson records it as abundant in hay-fields all over north Lancashire, whilst Robson says that it is particularly abundant along the coast of Northumberland and Durham, although uncertain in its appearance, abounding one year and very rare the next, and Fenn notes a similar uncertainty in its appearance, the insect abounding at St. Margaret's, in 1889, very rare in 1890. On August 5th, 1891, their cocoons were so common on the stems of rough grass on Helpston Heath (nr. Peterborough) that they made quite little white patches in places when seen from a distance (Morley). Clarke notes it as abundant on the coast, and widely distributed throughout the inland districts of the Isle of Man, in June. Henderson found it in abundance in Lundy Island, from the sea level to the highest point of the west coast, near the lighthouse; the imagines swarmed, whilst the pale straw-coloured cocoons, and the black protruding pupa-cases, were attached to grass culms, heather stems, rushes, and even chalk blocks. B. Adkin records it as common in the Scilly Isles, and R. Adkin from Sutherland, up to 2,000 feet. At Folkestone, Dover, Kingsdown, Freshwater, Sandown, Shanklin and Ventnor, it abounds on the cliffs near the sea, and at Cuxton and Reigate on the chalk downs, inland. So varied indeed are its localities, that one might mention probably most of the possible natural conditions in this country without exhausting them. The banks of a railway cutting at Madeley (Daltry), railway banks at Owston (Dixon), railway banks and rough grass fields nr. Enfield, also the railway banks in the New Forest (Edelsten), on the sandhills nr. Burghead (Gordon), on the coast of Kincardine and Forfar (Reid), coast districts of Kent and Essex (James), more plentiful on the coast of Norfolk (Atmore), on the sandhills between Troon and Ayr, also in the Cumbraes (Dunsmore), on the downs at Eastbourne (Edelsten), and the sides of the limestone hillsides at Clevedon (Mason), a rough grassy undercliff near Brooke, Isle of Wight (Hodges), in fields bordering Epping Forest (Bayne), a grass slope by the sea at Swanage (Alderson), are a few of the reported localities. Harker says that the imago emerges generally from 10.30 a.m. to noon. On the continent it extends from Sicily, Italy, and southern Europe generally, to Finmark and the shores of the White Sea; it is recorded from the Canary Islands, but not from continental Africa, and the recorded Asiatic localities (excluding Asia Minor), are of the most uncertain character. We have found it high up the mountains in Piedmont (to 5,000 ft.), on the wooded slopes of Lac Bourget, near Aix-les-Bains, in the Forest of Fontainebleau, on heathy ground, and other widely differing places. There are described Arctic and Alpine races, as well as southern and eastern ones. It is rather rare in the Channel Islands, on the cliffs, although it occurs abundantly in the Scilly Isles, etc. Selys notes that in his garden, at Longchamps, there is a gently sloping field, the lower end of which is marshy and abuts on the Geer. In this marshy part he finds *A. trifolii*, in the upper drier part, *A. filipendulae*, only occasionally one sees a stray *A. trifolii* in the latter part, although the field is continuous. This localisation is possibly due to a real specialisation of food-plants, of which, however, little is yet known. Selys has never observed any cross-pairing between the species on this ground, nor noticed any examples that he would consider as possible hybrids.

TIME OF APPEARANCE.—The insect generally known in Britain as the "early" *A. filipendulae*, occurring in late May and early June is referred to *A. hippocrepidis*, Stephs. The true *A. filipendulae*, however, sometimes occurs in late June, and continues to do so in different districts until the end of September, the latest appearing, generally, in the marshy districts of our southern coasts. Martorell says that at Barcelona it occurs in May and lasts a month, whilst, in the meadows of Spanish Galicia, Velado notes it as appearing in May and June (are these *hippocrepidis*, St.?). In Roumania it does not occur until the beginning of July, and continues until the end of August (Caradja); in France, in Ille-et-Vilaine it emerges in July and August, abounding at St. Malo, on the dunes, in early August, but rarer inland (Oberthür); at Nohant it is found from June 20th to July 20th (Sand), and from June to August, at Rheims, in fields and woods (Demaison), whilst the last week of June is reported for the dept. Loir-et-Cher (E. Harrison). In Bulgaria, it occurs near Sofia in May and June (Bachmetjew), in Austria it occurs from June 4th to September 9th (only one after August 31st) (Fritsch), whilst in Baden it lasts from the end of May to August (Reutti), end of June and July in the southern, July and August in the northern, parts of Norway (Aurivillius); in Switzerland it appears by the end of May in the plains, and continues throughout June and July (Frey); very common during the whole of June in Greece (Staudinger), May to July in Sicily (Tedaldi), July 24th-26th, 1896, July 22nd-26th, 1897, July 22nd-28th, 1898, at Aix-les-Bains (Tutt), July 18th-21st, 1890, at Tancarville in Normandy (Leech), July 9th, 1898, and following days, in the Laerdal, Scandinavia (Petterssen), from the end of June to the end of July, in the Baltic provinces (Nolcken). Reid notes it as appearing in July, on the Aberdeenshire and Kincardine coast, and Mason, in July at Clevedon; Merrin notes it in June in the Gloucester district, and Hodges that it swarmed from the end of July until September, 1898, in South Devon; Hellins found larvæ at Branscombe, between Seaton and Sidmouth, in July, the imagines emerging in August; Bostock found imagines at Land's End in June, and on Cannock Chase the same month, whilst Chaney notes its average time of appearance from July 3rd to August 15th, in the Chatham district; Fletcher records it from Totland Bay, Isle of Wight, in late August and September, Alderson from Swanage, in August, 1891, Whittle gives June 24th and August 13th as the earliest and latest dates at Southend, spread over a series of years, and says that in Essex, the species emerges in July, and lasts well into August. Henderson notes it as most abundant in July, 1887, in Lundy Island, and Clarke, June, 1887, in the Isle of Man. Riding received cocoons from Troon on July 12th, 1897, some emerged during the journey, and continued to do so for over three weeks, only one example with 5 + 6 united, whilst at Folkestone it was very abundant throughout August, 1892, some specimens fresh at the end of the month, many were cripples, chiefly ♀s, possibly due to the ♂s disturbing and pairing with them before the wings had fully expanded (Adkin), and at Eastbourne, in August, 1887, the species was common, below the average size, and the spots in the majority of examples united in pairs (Adkin); first week in August, 1890, at Howth (Harker). It is impossible to deal with a tithe of the dates (received from correspondents or published in the magazines). The following, spread over many years, are representative: June 23rd, 1856, at Hollingbury Combe, June 30th, 1856, at Brighton (Image), June 19th, 1857, at Wandsworth (Blackmore), September 2nd-7th, 1860, June 9th-July 4th, 1863, July 18th, 1864, August 3rd-5th, 1867, July 29th-August 26th, 1874, very worn, June 24th-August 1st, 1875, June 20th-August 15th, 1885, June 12th larvæ, 29th pupæ, imagines to August 8th, 1886, July 2nd-23rd, 1887, August 18th, 1888, June 8th larvæ, 10th-13th pupæ, July 20th-August 1st, 1889, July 27th, 1890, June 20th-July 4th, 1891 pupæ, June 4th larvæ, July 9th-August 28th, 1892, July 25th-August 5th, 1893, at Deal (Fenn), June 15th-July 6th, 1868, at Caterham Common (A. H. Jones), August 1st-7th, 1871, very abundant at Caterham (Wells), June 24th, 1878, July 6th, 1879, earliest dates at Rugby (Wilson), July 12th, 1872, at Whitby, August 1st, 1874, at Darenth, July 2nd, 1876, June 23rd, 1878, August 10th, 1879, nr. Bromley, June 30th, 1892, at Gravesend, May 8th, 1893, at Fletching (? *hippocrepidis*), August 29th, 1894, at Caterham (Bower), October 18th, 1871, freshly emerged, at Malvern, Lincs. (Towndrow), July 10th, 1874, nr. Winchester (Richardson), July 3rd, 1874, July 27th, 1875, at Sulham, August 6th, 1876, at Warren, July 31st, 1880, at Streatley, July 28th, 1882, at Pangbourne, July 28th, 1882, at Whitchurch, July 14th, 1884, at Hartley Row, July 23rd, 1884, at Goring, June 24th, 1887, at Caversham, July 2nd, 1888, pupæ, at Marlow, July 15th, 1888, at Henley, July 12th, 1889, at Aldermaston, July 18th, 1889, at Bulmershe, July 23rd, 1890, in the New Forest, August 1st, 1890, at Butterwood, August 11th, 1891, at Hardwick, June 17th, 1893, in Pamber Forest (Holland), September 26th, 1877, four specimens, small, freshly emerged, nr. pupa-cases, nr. Reigate (Lang), August 21st, 1880, July 30th, 1882, at Hitchin Wood, August 9th, 1880, at Wilbury Hills, July 29th, 1882, at Stagenhoe (Durrant), July 6th, 1881, July 5th, 1886, earliest dates near York, June 19th, 1895, earliest date at Spurn (Hewett), August 2nd, 1881, bred July 6th-19th, 1888, bred July 25th, 1890, caught at Portland, July 28th-August 5th, 1883, bred June 1st-July 6th, 1893, at Isle of Purbeck (Bankes), mid-August to September 16th, 1883, at Morthoe (Riding), July 7th, 1886, at Armagh (Johnson), August 29th, pupæ, emerged August 30th-September 3rd, 1886, at Deal, August 6th, pupæ, emerged until August 23rd, 1888, at Mudstone Bay, Brixham, June 22nd-24th, 1889, larvæ and pupæ only, in Warren, Folkestone, July 6th pupæ, emerged July 10th-31st, 1891, at Clacton, June 20th-26th larvæ and pupæ, first imagines (2) seen June 25th, 1892, at Folkestone, July 18th, 1896, imagines and pupæ abundant, July 1st, 1897 larvæ only, at Benfleet (James), July 7th, 1887, bred, from Gloucester, July 21st-September 1st, 1888, July 22nd, 1893, swarming, at Cuxton, August 10th-17th, 1888, August 1st-15th, 1890, at Deal, August 15th, 1888, at Folkestone (Tutt), August 5th, 1887, August 4th, 1890, at Folkestone, July 26th, 1891, at Kenley, July 18th, 1892, at Holmesley (Bloomfield), June 17th, 1888, larvæ and pupæ only, April 22nd, 1889, young larvæ only, at Walton, August 6th, 1888, pupæ, at Folkestone, July 25th, 1892, at Swanage, August 21st, 1892, at Reigate, June 9th, 1895, larvæ and pupæ, at Southend, July 19th, 1895, pupæ, at Deal (Williams), July 1st-7th, 1889, at Harrow, July 20th, 1895, at Leicester, July 3rd, 1897, at Owston (Kaye), June 26th, 1889, in boggy meadows at Hartley Wintney, June 23rd, 1892, June 13th, 1894 (? *hippocrepidis*), among coarse grass at Fort Hubblestone, Milford Haven, June 17th, 1893, on sand-hills at Tenby (Robertson), July 6th-26th, 1890, at Lyndhurst (Simes), July 15th, 1890, at Rhinefield (Goss), July 18th-25th, 1890, abundant at Abersoch (Arkle), August 11th, 1890, at Penzance, September 4th, 1894, at Southend (Burrows), July 25th-27th, 1890, between Southend and Hadleigh (Cockerell), June 7th, larvæ, June 12th, pupæ, July 8th, 1890, imagines, on Cotswolds (Lifton), August 1st, 1891, at Swanage, June 29th, 1894, at Toft, July 28th-August 4th, larvæ few, pupæ abundant, imago one, imagines bred August 11th-18th, 1898, at Sidmouth (Raynor), August 5th, 1891, at Helpston Heath, nr. Peterborough (Morley), August 10th-23rd, 1891, at Eastbourne (Adkin), July 3rd-23rd, 1892, July 1st-23rd, 1893, July 2nd-24th, 1896, in Wyre Forest (Abbott), June 20th-July 4th, 1892, in Guernsey (Hodges), July 6th, 1892, at Folkestone. July 26th, 1894, at Gomshall (Helps), July 29th-August 1st, 1892, at Swanage, very abundant (Bloomfield), August 5th, 1892, pupæ and freshly-emerged imagines at Sidmouth (Crabtree), July 15th-August 5th, 1893, at Swanage (Mackonochie), May 29th, 1893, earliest date, also much later at Enniskillen (? *hippocrepidis*) (Brown), June 7th, 1893, June 22nd, 1895, June 27th, 1897, nr. Leicester (Dixon), July 3rd, 1893, at Madingley (Farren), July, 1893, in Cumbrae, July 5th-19th, 1894, at Stonehaven, July 18th, 1896, at Troon (Dalglish), July 21st, 1894, at Peterborough (Mousley), July 22nd, 1894, cocoons abundant at Southend (Whittle), July 25th-August 24th, 1894, at Dover (Page), June 20th-30th, 1895, at Owston (Bouskell), July 11th, 1895, July 18th, 1896, July 11th, 1897, first imagines seen at Guildford (Grover), June 16th, 1896, at Shoreham (Barclay), August 11th, 1896, at Sidmouth. August 4th, 1897, at Starcross (Studd), June 16th, larvæ, pupæ and imagines, latter till July 11th, 1897, very abundant at Blyth (Crass), August 4th, 1897, at Folkestone (Cross), June 16th, 1897, at Weymouth (Bayne), July 11th, 1897, at Carlisle (Day), July 11th, 1897, at Redcar (Lofthouse), July 3rd-20th, 1898, at Oban (Sheldon), July 7th, 1898, at Torghätten (Chapman), August 20th, 1898, at Eastbourne (Clark), August 8th-15th, 1898, usually in July, at King's Lynn (Atmore), July 27th-August 2nd, 1898, at Sandown, just appearing (Dadd), July 31st-August 15th, 1898, at Shoreham, Kent (Carr), July 14th, 1898, worn, at Bovey Tracey, July 25th-27th, 1898, nr. Paignton (Hamm).

Localities.—Scotland: fairly generally distributed, extending into Sutherland, distribution, however, not at all well-known. Ireland: everywhere, but most common on eastern side of island (Kane). The following list is evidently very incomplete. As usual, our knowledge of the most common insects is generally in inverse proportion to their abundance. Aberdeen: Muchalls (Maddison), Kintore, etc., many inland localities (Reid). Antrim: Portrush (Maddison), many places, common on the Belfast hills (Kane). Argyllshire: Oban, not common (Sheldon). Armagh: Armagh (Johnson), nr. Armagh (Kane). Ayrshire: between Troon and Ayr, Millport in the Cumbraes (Dunsmore). Berks: Sulham, Bulmershe, Pangbourne, Aldermaston (Holland), Reading district, common (Hamm), Hartley Wintney (Robertson). Bucks: Princes Risboro' (Bayne), Marlow (Holland). Cambridge: Madingley, Cherry Hinton (Farren), Boxworth (Thornhill). Carnarvon: Abersoch, abundant, Tan-y-Bwlch (Arkle). Cheshire: local (Walker), Birkenhead (Fish), Oakmere and Knutsford (Chappell), Delamere (Cooke). Clare (Kane), coast district (Lawless). Cork: nr. Roches' Point, nr. Kinsale, Glandore, Castlehaven, Crookhaven, Castletown Bere (Kane), nr. Skibbereen, abundant (Wolfe), Mallow, abundant (Newland), Glengariff (Adkin). Cornwall: Land's End (Bostock), New Quay (Maddison), Penzance (Burrows). Cumberland: Lingholm (Beadle), Carlisle (Day). Derby: common (Payne). Devon: general in north Devon (Cooper), Barracombe (Adkin), Bovey Tracey, Paignton (Hamm), Starcross, Sidmouth (Riding and Studd), Seaton (Reading), Wallacombe (Mera), Morthoe (Riding), Brixham (James), Plymouth (F. Briggs), Branscombe (Hellins), Lundy Island (Mera). Donegal: Bundoran, nr. Donegal, shores of L. Swilly, etc. (Kane). Dorset: Portland, abundant, Weymouth (Richardson), Swanage (Alderson), Bere Regis, Lyme Regis (Battley), Weymouth (Forsyth), Purbeck (Bankes). Down: various places (Kane). Dublin: Killiney, Clondalkin, Malahide Skerries, Lambay (Kane), Howth (Harker). Durham: general on coast, Hartlepool, etc. (Robson). Edinburgh: North Berwick, Longniddry, Pettycur, etc. (Evans). ? Elgin (Moray dist.): Burghead, Knock of Alves, Rother, etc. (Gordon), Duffies Hillock (Robertson). Essex: Colchester (Harwood), Clacton, Benfleet (James), Southend (Whittle), Hadleigh (Cockerell), Leigh (Bouttell), Epping, Loughton (Garland), Chingford (Bayne), Walton (Williams). Fermanagh: Belle Isle, Lough Erne, Portora, etc. (Kane), Enniskillen (Brown). Forfar: coast (Reid), Bervie (Gunning). Galway: Galway (Harker), widely spread, not common at Clonbrock or Ardrahan (Kane). Glamorgan: Swansea (Robertson), Penarth (Birkenhead). Gloucester: Gloucester dist., common (Merrin), Newnham, Cotswolds, widely distributed (Lifton). Hants: Basingstoke dist., common (Hamm), New Forest (Edelsten), nr. Christchurch (Fowler), Lyndhurst (Simes), Rhinefield (Goss), Winchester (Forbes), Portsmouth, common (Pearce), Isle of Wight—Ventnor, Shanklin, Sandown, Freshwater (Riding and Tutt), Totland Bay (Fletcher), Compton Bay (Hodges), Pamber Forest, Butterwood, Odiham, Hartley Row, New Forest (Holland). Hereford: Tarrington (Wood), Leominster (Hutchinson). Herts: Hitchin, not common, Wilbury Hills, Stagenhoe (Durrant), Royston, Tring (Bayne), Barnet (Lockyer). Hunts: St. Ives (Jagger), Yaxley Fen (Bond), Abbott's Kipton (Bayne). Isle of Man: abundant on coast, rarer inland, Douglas Head, very abundant, etc. (Clarke). Kent: Gravesend, Bromley, Darenth (Bower), Shoreham (Carr), Deal, Dover, Canterbury, Folkestone, Cuxton, Strood, etc. (Tutt), Sandwich (Bayne), Honor Oak Park (Bate), Wrotham (Smart), Maidstone (Elgar), Eltham dist., now rare (Fenn), Otford and Sevenoaks (L. Newman), Chatham dist. (Chaney). Kincardine: coast districts, abundant (Reid), Stonehaven (Dalglish). King's co. (Kane). Kerry: Killarney and Valley of the Roughty above Kenmure, Sneem, Ballinskellig's Bay, about Dingle and Ventry, nr. Castle Gregory (Kane). Lancashire: locally abundant (Ellis), coast from Blackpool to Crosby; north Lancs., common (Hodgkinson), Fleetwood (Baxter), nr. Bolton (Johnson), Chat Moss (Chappell). Leicester: Owston, John o'Gaunt, Saddington (Bouskell), Leicester (Dixon), Loughborough (Wieldt), Gumley (Matthews), Aylestone (Rowley). Lincoln: nr. Lincoln (Mousley), Malvern (Towndrow), Newball (Carr), Toft (Raynor). Londonderry: nr. Londonderry, Magilligan (Kane), Lough Swilly (Campbell). Middlesex: Harrow (Rothschild), Green Lane (Bonhote), Enfield (Edelsten), nr. Finchley (Thomas), Kingsbury (Bond), Mill Hill (South), Old Oak Common (Godwin), Isleworth (Meyers), nr. Ealing (Cockerell), Ruislip (Watts), Harrow Weald (Rowland-Brown), Harefield (Wall), Pinner Drive, Oxhey Wood (Melvill). Monaghan: Monaghan, nr. Drumreaske, nr. Favour Royal (Kane). Norfolk: King's Lynn, etc., more common on coast (Atmore), Hemsby (Pitman). Northampton: Peterborough (Mousley), Helpston Heath (Morley). Northumberland: Blyth, Old Hartley (Crass). Notts: Mansfield (Daws). Oxford: Warren, Streatley, Hardwick, Caversham, Goring, Whitchurch, Henley (Holland), Chinnor (Bayne). Pembroke: Tenby, Milford Haven (Robertson). Sligo: Sligo (Russ). Somerset: Clevedon (Mason), Castle Cary, common (Macmillan), Bath (Greer). Stafford: Madeley (Daltry), Cannock Chase (Bostock). Suffolk: common (Bloomfield). Surrey: Guildford (Grover), Reigate (Tutt), Caterham (A. H. Jones), Kenley (Bloomfield), Box Hill (Cockerell), Riddlesdown (Crowley), Gomshall (Helps). Sussex: generally distributed and abundant (Jenner), Brighton, abundant (Merrifield), common on downs and coast districts, Shoreham, etc. (Fletcher), Eastbourne (Edelsten), Lancing (Rye), Lewes (W. E. Nicholson), Fletching (Bower), Groombridge (Blaber), Tilgate Forest (T. Briggs), Wannock (Pearson). Sutherland: mt. Suliven at 2,000 ft. (Adkin). Tyrone (Kane). Warwick: Rugby (Wilson). Waterford: Dunmore, Cappagh, and elsewhere in the valley of the Blackwater, Tranmore, Dungarvan, Minehead (Kane). Westmeath: various places (Kane). Wexford: Rosslare, Saltee I., Ballyteague Bay (Kane). Wicklow: Greystones, Newcastle, Wicklow, Arklow (Kane). Wiltshire: Calne (Eddrup). Worcester: Wyre Forest (Abbott). Yorks: Redcar and Richmond (Sang), Whitby (Bower), Horsforth (Mansbridge), Askham Bog (Prest), Barnsley (Harrison), Bramham (Smith), Edlington Wood (Harrison), Filey (Taylor), Spurn (Hewett), Flamborough Head (Mosley), Goole (Porritt), Huddersfield (Varley), Ledsham (Smethurst), Leeds (Birchall), Pontefract (Hartley), Selby (Rockett), Sheffield (Doncaster), Wakefield (Talbot), Sandburn, Strensall, York (S. Walker).

Distribution.—Africa: Canary Islands, St. Vincent (Bory). Asia: Tokat (Speyer), Dahuria (Pallas). Austria: Lemberg, Vienna (Garbowski), Agram, Bärn Bludenz, Bregenz, Brünn, Bugganz, Cilli, Gresten, Hausdorf, St. Jakob, Karschau, Kessen, Kirchdorf, Kremsmünster, Leutschau, Linz, Mistek, Neutischein, Prague, Rosenau, Rottalowitz, Salzburg, Senftenberg, Taufer (Fritsch), Wippach in Carniola, Innsbruck 3,800 ft., Heiligenblut at 4,400 ft., nr. Mürren at 5,000 ft., Buda (Speyer), Bucovina, generally distributed (Hormuzaki), Cracow (Zebrowski). Belgium: general (Sélys), Namur (Colignon). Bulgaria: Sofia (Bachmetjew). Denmark: common, and generally distributed (Aurivillius). France: distributed throughout the country, very common in north-west France, Le Havre, etc. (Dupont), Nohant, Sologne. St. Florent, Guéret, Murols, Lac Chambon, Auvergne, generally common (Sand), Vernet-les-Bains, Cauterets, Ille-et-Vilaine, St. Malo, Cancale (Oberthür), Bourg d'Oisans, Aix-les-Bains, Fontainebleau (Tutt), Paris, common (Lucas), Depts. of Meuse, Moselle, Meurthe, Doubs, Puy-de-Dôme, Savoy (Speyer), nr. Gavarnie (Pierret), Rheims dist., very common (Demaison), Dept. l'Aube (Jourdheuille). Loir-et-Cher (Harrison), Tancarville (Leech), Loire-Inférieure (Bonjour), Calvados, St. Quentin (Dubus), Dept. du Nord (Dupont). Germany: everywhere (Heinemann), Alsace, common (Peyerimhoff), Silesia (Assmann), Thuringia, common (Knapp), Leubusch (Prittwitz), Hilden, nr. Düsseldorf, rare, Urdenbach, common (Kirby), nr. Stettin (Hering), Baden, common, Pfalz, Würtemburg, Nassau (Reutti), Saxony (Dadd). Greece: Parnassus and Veluchi, common (Staudinger). Italy: northern provinces, common, central and south, less common (Curò), Piedmont, Liguria, Hügel, Tuscany (Speyer), Naples (Costa), Sicily (Frey), Montecuccio, Mondello (Tedaldi). Netherlands: in all provinces (Snellen). Roumania: generally distributed and common (Caradja). Russia: Lower Volga dist. (Eversmann), St. Petersburg, Livonia, Ciscaucasian dist. (Speyer), Crimea (Melioransky), Caucasian provinces, common (Ménétriès), Baltic provinces, common (Nolcken), Åland, Åbo (Lampa), Finland to 60° 30′ (Reuter), North Russia, White Sea to Urals, Moscow district, Poland, mouth of Danube to Dnieper, Volga district and Transcaucasia (Erschoff). Scandinavia: common in Sweden, Norway and S. Finland, most northerly locality, Dalecarlia (Aurivillius), Grötö, 68° N. lat. (Schneider), Norway to 67° 50′ N. lat. (Reuter), Arctic Norway, Dovrefjeld, Oestersjön, Christiania, Ringerige, Drommen, Smölen (Schöyen), Dovre (Siebke), Upland, Stockholm, common (Boheman), Upsala (Belfrage), Saltdalen (Sommerfelt), Laerdal, St. Bergenhus (Petterssen), Torghätten 65° 54′ (Chapman). Spain: Galicia (Macho Velado), Province of Teruel (Zapater), Barcelona dist., generally distributed (Cunì y Martorell). Switzerland: generally distributed (Frey), nr. Bellinzona, Glarus (Speyer), everywhere in the Engadine (Mengelbir), Oberalbula, common (Zeller), Simplon (Jordis).

ANTHROCERA HIPPOCREPIDIS, Stephens (*nec* Hb.).

Synonymy.—Species: *Hippocrepidis*, Stephs., "Illus.," i., p. 109 (1828); Wood, "Index Entom.," iv., fig. 6 (yellow ab.) (1839); Kirby, "Cat. Lep. Het.," p. 70 (1892); "Handbook," etc., p. 94 (1897); Tutt, "Ent. Record," pp. 87-88, 103-104, 106, 169 (1897); South, "Entom.," xxx., pp. 181-183 (1897). *Ochsenheimeri*, Boden, "Entom.," xviii., p. 317 (1883); South, "Entom.," xxiv., p. 233, in part (1891). *Filipendulae*, ? Newm., "Brit. Moths," p. 24, in part (? 1869); Briggs, "Trans. Ent. Soc. Lond.," 1871, pp. 434-435, in part; Tutt, "Ent. Rec.," ii., p. 110 (1891).

Original description.—Alis anticis nigro-cyaneis, maculis sex rubris, subtùs omninò confluentibus, posticis rubris sinuato viridi-cyaneo, abdomine immaculato. This varies in size, like *A. filipendulae*, which it greatly resembles; but the border of the posterior wings is considerably more distinct than in that insect, and undulated internally, the 6th spot on the anterior wings, the one towards the anal angle, is generally small, with a coloured nervure passing through it; the under surface of the anterior wings with the disc entirely red, and the maculations not defined. Above, the anterior wings are blue-black, with six red spots, disposed as in *A. filipendulae*, and the posterior red, with an undulated greenish-blue margin; the abdomen immaculate (Stephens, *Illustrations British Entomology*, etc., i., p. 109).

Imago.—Anterior wings, 23-36 mm., blue-green, or green in colour, with six crimson spots, the lower of the outer pair usually ill-developed, often with a dark nervure passing through it. Posterior wings crimson, with a narrow marginal border (but broader than in normal *A. filipendulae*).

Sexual dimorphism.—Males expand from 23 mm.-32 mm., females from 26-36 mm., but on the whole the females are considerably larger than the males. The males have also the 6th spot much less defined than the females. Of two examples with it entirely absent, both are males, of 20 others, in which it is represented by a few red scales, all are males, whilst in 32 others, arranged in order following the ill-developed nature of this spot, only two are females, so that of the 54 which show spot 6 with its least development, two only are females. Of 150 other examples, the 20 in which the 6th spot is almost as large and well-developed as in typical *A. filipendulae*, are all females. The males also have, on an average, a wider marginal band to hind-wings than the females, and, taken as a whole, one is struck with the specialisation of the sexes, the males in the direction of *A. trifolii*, the females in the direction of *A. filipendulae*. Bateson, who had the most distinctly five-spotted example we have ever captured, with no trace of a 6th spot on the upper, and only a few red scales in its position on the under, side, reported it as having genitalia similar to those of *A. filipendulae*.

Variation.—Stephens says that, like *A. filipendulae*, this species varies considerably, from the spots being more or less confluent or obliterated. We have seen no really good confluent aberrations of this species, and in our series of 280 specimens, only two are well-defined examples of ab. *cytisi*, *i.e.*, analogous with the ab. *cytisi*, Hb., of *A. filipendulae*, two or three others having the central pair of spots united. One male example has the right fore-wing 9 mm. in expanse, the corresponding left fore-wing being 12·5 mm. Another male has the left hind-wing with a hole punctured through it, as if eaten out by an ichneumon grub, another has the right fore-wing rounded apically, and with a projecting point in the centre of the outer margin ≻, another has the right hind-wing 6 mm. long, the left 9 mm., whilst others exhibit considerable modification in the narrowing or apical rounding of the fore-wings. One example has the right pair of wings of full size, but composed of whitish (almost transparent) membrane, with the ordinary red spots and hind-wings faintly pinkish, the left pair of wings normal. Another is distinctly pallid, ab. *pallida*, n. ab., the ground colour of the fore-wings greenish-grey, the spots of fore-wings and hind-wings pale pinkish-red, the marginal border of a similar greyish hue to the ground colour of the fore-wings. In two or three examples the bases of the hind-wings are orange, and one other is somewhat yellowish on the outer margin of the left hind-wing. A yellow form, ab. *lutescens*, n. ab., is described by Stephens (*Illus.*, i.,

p. 109), and figured by Wood (*Ind. Ent.*, iv., fig. 6). Stephens described the yellow form of this *Anthrocera* as having "the anterior wings above of a pale yellowish-green, with six pale lemon-yellow spots; the posterior wings of the latter colour with a bluish-green border." He further remarks that of this form he has "seen three specimens only, which were reared from larvæ taken near Darenth wood, where the wild liquorice abounds." We have in the preceding paragraph noted the variation in the size and development of spot 6, which may be totally absent, or form a large well-defined oval spot. We have a specimen taken in 1894, in North Kent, with 4 and 6 absent on the left fore-wing, and 2 and 3 rather small.

Larva.—The larva, in the *hybernating stage*, rests with its head completely withdrawn ventrally. The dorsal line forms a gradual arch, the ventral area being closely appressed to the surface on which the larva is resting. *Dorsally:* The body appears to be divided longitudinally into three distinct areas, the central area (owing to a slight sinking outside the line of the dorsal warts) appearing much raised above the level of the lateral areas. The colour is of a pale amber, shiny, and almost transparent; the segmental incisions clearly defined. The mediodorsal area exists as a clear longitudinal band of the ground colour. On either side of this band is a much darker subdorsal band, which contains the dorsal warts. Each of these forms a raised cushion, which bears about ten finely spiculate hairs, each arising from a small black tubercular point. These warts are readily separable into two portions, corresponding with tubercles i and ii respectively. In each portion one hair is central, and is surrounded by four others. The hairs are glassy-looking, covered with fine spiculæ or branching points. On the pro- and mesothorax the dorsal warts are united, as they are also on the anal segment. The subdorsal longitudinal bands owe their darker colour to a series of brownish patches, which separate the dorsal cushions on successive segments; a short, but very black, transverse line edges (on the anterior margin of each segment) the front of each brown patch, which fully occupies the space between the incision and the posterior portion of the wart behind it. There is also a longitudinal supraspiracular band of this darker colour. *Laterally:* The supraspiracular band is seen to contain the supraspiracular warts (iii), each of which carries an inner ring of six long spiculate hairs, and a partial outer ring (consisting of three hairs) on the upper edge, which enclose one central hair. Each hair arises from a conspicuous but minute blackish-brown tubercular point. The supraspiracular warts are also found on the thoracic segments. Beneath the spiracles is a longitudinal series of similar subspiracular warts (iv + v), bearing tuberculate and spiculate hairs, six to eight on each, surrounding a larger central one. The marginal warts (vii) are very similar, but smaller, and run along the base of the prolegs. Between the subspiracular and marginal series are two hair-bearing tubercles, placed close together, on the abdominal (not thoracic) segments; these represent Dyar's tubercle vi. The prothoracic and abdominal spiracles are black; each forms a conspicuous protruding cone, which is most prominent when the larva is disturbed. The prothoracic spiracle is placed well back on the segment. *Ventrally:* The head is very pale brown, ocelli black, mouth parts whitish (almost transparent). The ventral area pale amber or yellowish. The true legs whitish, shiny, and glassy-looking, each with a very minute brown terminal hook, and two or three fine, short, glassy-looking hairs at the joints. The prolegs are also shiny and glassy-looking, each with 12-14 very conspicuous black hooks on the inner side of the flange, forming the terminal joint. The anal prolegs similar to the abdominal prolegs, but placed transversely, not longitudinally. [We are indebted to Mr. South for the larvæ described, which he says came from eggs "laid by the early June *A. filipendulae*." Description made January 21st, 1898.] We have unfortunately been unable to get a full-fed larva recently, and hence cannot give a description. Stephens describes the larva as "greenish, with a broad yellowish stripe on each side, and a row of black spots, the head black, varied with white, the anterior legs brown, the following yellow, the rest black."

Cocoon.—The cocoons measure from 25 mm.-27 mm. in length, 6 mm. in width; of a pale straw-yellow colour, strongly ribbed longitudinally, spun on a grass stem; of the usual spindle shape, with a little silk beyond the ends on the stem, and also a little silk round the stem. The cocoon opens for the emergence of the pupa, by one dorsal flap, which lies on the dorsum of the protruding pupa, its apex at the thoracic-abdominal incision; the two side slits show a small corner of the 5th abdominal segment.

Pupa (dehisced).—The dorsal headpiece stands at the anterior margin of the prothorax, and appears to have no other connections; it is narrow transversely, much wider on the posterior than anterior margin. The prothorax is a piece of similar shape, but with the outer margin folded down; the tracheal linings project from its outer inferior angle internally. The spiracle is a mere hollow between the pro- and mesothorax, without any obvious margin at the surface, beyond the plain edges of the segments, but, within the chink, the prothorax has a dense coating of very short hairs. There is a small chitinous island just behind this point, in the delicate membrane lining the groove from which the antenna cases have been raised. This is probably a slightly exposed portion of the femur of 2nd leg. Looking internally, and somewhat below this, the tracheal linings from the spiracle between the meso- and metathorax are very evident. There is no trace of maxillary palpi, except a wide, flattened base of the maxillæ, extending outwards under the eyes and ending in a point. This flat portion represents the base of the maxillary palpus, and no further portion reaches the surface, unless a minute, apparently separate, piece, at the upper end of the 1st leg, be it. This piece seems more probably to be the extremity of the femur, the more especially as a portion of the femur and trochanter (there being a joint in it) is seen between the maxillæ and 1st leg (*i.e.*, the tibia and tarsus of 1st leg). This 1st leg reaches up to the hollow between the eyes and antennæ, and down to four-fifths the length of the wing, where the tarsi terminate. The 2nd leg is outside this, and does not reach up so far by ·6 mm., and only reaches downwards to end of 1st leg, when it disappears between 1st leg and antennæ, which cover it. The wings appear to be free from the abdominal segments, but doubtfully from the first, and the first abdominal incision distinctly to open dorsally is that between 3 and 4, but laterally and ventrally that between 2-3 is open, and is probably so dorsally also, though not evident in the specimen under examination; the segments, where covered by the wings, have a very thin texture, white and delicate, *viz.*, the ventral aspects of 1, 2, 3. Where the maxillæ and 3rd legs extend for fully two segments width beyond the wings, the venters of 4 and 5 are also delicate, and are hollowed to receive them, as are also 6 and 7, to which the appendages may reach in pupal movements. The maxillæ seem to be united, but the legs are free from these and from each other. The anterior dorsal margin of metathorax is deeply hollowed by the backward projection of the mesothorax. The 1st and 2nd abdominal segments, except some indefinite depressions, are simple and without sculpturing, and are, with the metathorax, somewhat depressed, forming a waist. The incisions are free to 7-8 (a ♂ pupa). *Dorsally*, the structures of 3-7 abdominal are almost identical, *viz.*, a narrow black line or mere thread, immediately behind the incision, then a delicate colourless zone, easily confounded with the intersegmental membrane proper; then the transverse line of hooks, looking, at a rough glance, like the anterior margin of the segment. The actual hook projects, and has its concavity backwards; it is very short and thick, and stands on a black chitinous base of the width of the hook, projecting forwards and overhanging sharply the colourless zone noted above, and passing backwards and spreading out and losing itself on the general surface. The thin chitin of the pale zone passes unchanged just between the heads of these black bases, and thickens rapidly backwards as it joins them on the general surface. Looking dorsally at the pupa, the hooks proper are not seen, but these parallel longitudinal striæ are very marked, especially their square black anterior ends over the pale membrane, which suggest a line of hooks directed forwards. Their total length is $\frac{1}{4}$ to $\frac{1}{5}$ the breadth of the segment. The tissue at the posterior margin of the segment has a narrow, thinner zone, which passes into the next intersegmental membrane. The hooks with the pale zone in front occupy the dorsal half of abdominal segment 4, about a fourth of 3 and 7. The central ones, 40 to 50 in number, are most marked, but there are nearly as many more fading out laterally, fewer on the posterior segments. On 8 they are not so distinctly formed, but they are practically the same as on 7. On 9 they form a transverse row of spines about the middle of the segment, round the dorsal half of its circumference, small, standing up boldly without the linear base or pale preceding area. The posterior edge of 9 has a few half obsolete spines or hooks, and 10 has an area of spines in two or three rows that, viewed dorsally, range with the series of hooks on the preceding segments; viewed laterally, they do so equally, the end of the segment dropping below them, and passing without a distinct ventral area to the 9th segment. The end of this pupa is occupied by the anal depression, the surrounding chitin, as well as that of the venter of the 9th segment where there is a linear depression, is very black and polished. The rest of the segmental surfaces are dull, with fine wrinkles. The appendages are more shiny and polished, but not so bright as the 9th and 10th abdominal segments. The fore-wings exhibit the neuration in raised ribs. The hind-wing is broadly exposed to the posterior margin of 2nd abdominal segment. Abdominal spiracles 1 and 2 are covered by margin of wings, the others are by no means conspicuous, being marked by a few wrinkles around them. Above and behind them is a marked pit on 2, 3, 4, 5, 6, 7, 8, and below them several longitudinal wrinkles, together marking out the "lateral flange," not otherwise developed.

On segment 3 is a scrap of dark chitin, just in the line of these wrinkles, which here fall on the delicate chitin beneath the wings. No definite marks of prolegs exist. When they do, as they often do, in Anthrocerids, they are probably slightly pathological, just as in *Smerinthus* where they often, but not usually, occur. Though there are no hooks or pale zones ventrally, the strong black line of the anterior margins of the segment is very marked, though wanting at the "flange," and therefore not continuous round the segment. The 8th abdominal spiracle does not afford a tracheal lining, as in Rhopalocera. The pits which run up each side of the mesothorax from the forward margin of the metathorax are well marked and quite pale at their deepest hollow—elsewhere the chitin is fairly dark and strong (black in the living pupa), and nowhere brown (green in living pupa), as in many Anthrocerids. The glazed eye is well marked across the cheek, as curved smoother area, with a very defined inner margin; the clypeus comes down very square to the maxillæ, so that, unless a trifling irregularity on its margin represent them, no other mouth parts are seen. Except those noted in connection with the prothoracic spiracles, no trace of hair or bristle is anywhere to be discovered. [Chapman. Described January 1st, 1899, from empty pupa-case from nr. Strood.] Stephens says that "the pupa is dusky-brown, with the abdomen greenish, spotted with black."

Dehiscence.—The apices of the pupal wings rest upon the outer surface of the cocoon, near the apex of the opening close to the stem (to which the cocoon is attached); to enable them to do this the pupa is drawn somewhat out of position, and the fore part of the pupa-skin is thrust back at an angle of 45° degrees from the grass stem. The separated antennæ-covers being thrown forward at 45° from the pupa-case, stand out horizontally in a conspicuous manner. They are attached to the headpiece which carries the eye-covers and maxillæ, the whole being attached to the rest of the pupa-case by the apices and inner colourless septa of the maxillæ. Viewed dorsally, the dorsal slit between the lateral halves of the dorsal headpiece, the prothorax and the mesothorax, extends to the posterior margin of the mesothorax and stands widely open.

Food-plant.—? Wild liquorice (*Astragalus glycyphyllos*) (Stephens). We doubt this very much, *Genista tinctoria* and *Lotus corniculatus* are both abundant where the species occurred in North Kent.

Habits and habitat.—The species is generally found in meadows and rough, grassy fields. Barrett says that in some rough fields on the top of Wenlock Edge, a range of hills in Salop, he found, in June, 1856, *A. filipendulae* in immense numbers, but searched in vain for *A. lonicerae*; returning to the same place a fortnight later, he found the latter species in equal profusion, but scarcely a specimen of *A. filipendulae* was to be seen. On grassy slopes, near the sea, at Cairnryan, Stranraer and Corsemalzie (Gordon), in meadows and pastures (Stephens), in a grass field near Ashford, and on railway banks at Grange (Crabtree), in meadows at Mill Hill, flying with *A. trifolii*, also in fields at Hailsham, but here never mixing with *A. trifolii* (James), in boggy meadows at Sketty Park, with *A. trifolii* (Robertson), in pasture meadows at Newstead Park (Wright), in the rides of the wood at Ashton Wold, at privet bloom (Prout), in fields, nr.

Winchester, with *A. trifolii* (Richardson), on railway banks at Cowran (Routledge).

Time of appearance.—From the middle of May to the end of June, according to the season, generally quite over before *A. filipendulae* has pupated, in 1888 (a very late year) was out in early July. Cross notes that on August 4th, 1897, *A. filipendulae* were in great plenty at Folkestone, but a friend living there gave him several examples of a six-spotted species, distinctly smaller than the later one, that he had taken plentifully on June 3rd of the same year. The following appears to refer to this insect: June 20th, 1810, nr. Coombe Wood (Stephens), June, 1856, on Wenlock Edge (Barrett), June 6th, 1868, abundant at Cirencester (Harman), second week in May until the second week of June, normally, June 16th, 1864, at Barnwell Wold, June 16th, 1871, at Castle Hill, Dover (Briggs), in May, in the metropolitan district (Boden), June 9th, 1874, with *A. trifolii*, at Winchester, first specimen of true *A. filipendulae* seen on downs July 10th (Richardson), May 25th, 1881, at Great Marlow (Davis), larvæ, pupæ and imagines at Grange, June 6th, 1881 (Carter), June 4th, 1883, at Newstead Park (Wright), June 25th-26th, 1887, June 19th, 1890, May 25th-June 24th, 1892, May 7th, May 20th-June 16th, 1893, June 16th-July 4th, 1894, worn, in North Kent (Tutt), June 1st-13th, 1889, at Mill Hill, never saw the insect here later than June 15th, May 27th-June 3rd, 1893, at Hailsham (James), occasionally at end of May, June 4th, 1889, July 8th, 1890, June 21st, 1892, June 8th, 1893, June 27th, 1894, at Cowran (Routledge), swarming in June, 1892, at Penarth (Birkenhead), June 11th, 1892, with *A. trifolii*, at Rickmansworth, May 22nd, 1893, at Northwood (South), May, 1893, May 28th, 1896, cocoons and imagines at Grange, June 5th, 1895, cocoons, emerged June 24th-30th, near Ashford, Kent (Crabtree), June 8th, 1893, at Sketty Park (Robertson), May 26th, cocoons, emerged June 3rd-7th, imagines on wing May 29th, at Enniskillen (E. W. Brown), May 24th, 1896, at Barmouth (Blagg), June 5th, 1896, at Cairnryan, Stranraer, June 10th, 1896, at Corsemalzie (Gordon), June 22nd, 1896, at Ashton Wold (Prout). In April, 1881, the larvæ of *A. filipendulae* were abundant, in various stages, in one locality at Instow, long before larvæ appeared in the usual haunts of the species (Hinchliffe). "A specimen taken near the Pont-de-l'Arche, on June 19th, 1897, in the locality, with *A. trifolii*, is very like the specimen of *A. hippocrepidis*, St., you sent to me from Kent; I could at the time find no other specimen of the six-spotted form" (Dupont).

Localities.—Bucks: Great Marlow (Davis). Cheshire: between Spital and Besborough (Moss). Cumberland: Orton Wreay, Newby (F. H. Day), Cowran (Routledge). Devon: Instow (Hinchliffe). ? Fermanagh: Enniskillen (E. W. Brown). Glamorgan: Penarth (Birkenhead), Sketty Park (Robertson). Gloucester: Cirencester (Harman). Hants: nr. Winchester (Richardson). Kent: Darenth (Stephens), Dover (Briggs), Folkestone (Cross), nr. Strood (Tutt), Ashford (Crabtree). Lancashire: Grange-over-Sands (Crabtree). Merioneth: Barmouth (Blagg). Middlesex (Wood), Metropolitan district (Boden), between Rickmansworth and Northwood (South), Mill Hill (James). Northants: Barnwell Wold (Briggs), Ashton Wold (Prout). Notts: Newstead Park, nr. Mansfield (Wright). ? Pembroke: Pembroke (Barrett). Shropshire: Wenlock Edge (Barrett). Surrey: nr. Coombe Wood (Stephens). Sussex: Tilgate Forest (Briggs), Hailsham (James). ? Wigtonshire: Cairnryan, Stranraer and Corsemalzie (Gordon). ? Wilts: Marlborough (Meyrick).

ANTHROCERID SPECIES.

In obtaining the materials for the study of the Anthrocerids from every possible source, we have been repeatedly called upon to formulate an opinion as to what constitutes a species in this particular genus. Few as are our British species, they afford representatives of some of the chief sections into which this somewhat unwieldy genus naturally falls, and in the study of their variation the question of species faces us at every turn. Is *A. rubicundus* cospecific with *A. purpuralis?* Are *A. viciae* and *A. charon*, Hb., the same species? Is *A. lonicerae* distinct from *A. medicaginis?* Can *A. dubia* be a mixture of *A. medicaginis* and *A. ochsenheimeri?* Are *A. trifolii* and *A. palustris* distinct? Can *A. seriziati*, the most extreme form of *A. palustris*, be specifically identical with *A. syracusia*, the most extreme form of *A. trifolii?* Should *A. hippocrepidis*, St., be united with *A. trifolii* or *A. filipendulae?*

The difficulty of species among the Anthrocerids does not lie so much in the intergrades met with, as in the tendency for a given condition of environment to produce a race with a well-defined facies, and the consequent determination whether there is sufficient distinction between two well-marked forms to warrant one in considering them species—thus we get the *viciae-charon*, the *lonicerae-medicaginis*, and *filipendulae-hippocrepidis* combinations. Not that intergrades do not occur, *trifolii* and *palustris* appear to offer such, yet the question of *syracusia* and *seriziati* as species turns rather upon their differentiation from *trifolii* and *palustris* respectively, to which forms they are undoubtedly attached. Considering these as combinations of the first grade, *i.e.*, the presumed species being little more than local races with a well-defined facies, there are combinations much more far-reaching in character, *e.g.*, not whether *medicaginis* = *lonicerae* or *ochsenheimeri* = *filipendulae*, but whether *medicaginis* = *ochsenheimeri* (the two having been combined as *dubia*, Staud.), and, therefore, whether *lonicerae* = *filipendulae*, two very distinct insects in their typical forms. The question of species, then, is a difficult one, and if one sums up the characters presented by certain Anthrocerids, one is often puzzled as to what should and what should not be considered the limit of specific forms.

Unfortunately in this genus, two out of the three early stages yield no characters that can be considered of value in this direction. One can often determine certain species of Lepidoptera by an examination of the eggs or pupæ alone. The eggs of Anthrocerids are, in their broad characters, almost identical, and the pupæ are equally generalised and similar, even when the imagines are most diverse. They present the same number of movable segments, the maxillæ, antennæ and 1st pair of legs reach to almost exactly the same points on the 5th and 6th abdominal segments, a slight difference in the colour or texture of certain segments alone remaining. The larvæ, too, are so little specialised that their structural uniformity is only equalled by their general similarity, a difference in ground colour, and the size of the black markings before and after the warts (which extend in longitudinal series throughout) being almost the only available characters at disposal. The imagines, although maintaining what may be called an average of stability, are subject to the most amazing variations, so that a single normally 5-spotted species, *A. trifolii*, may present the extreme characters of *A. lonicerae* or *A. erythrus*, and what is true of this, is true in a greater or less degree of all the species. Neither the border of the hind-wings nor the antennæ offer fixed characters, and in the latter a difference of one-third in length will sometimes occur in the males of the same species from a single locality.

One may ask what is left on which a differentiation can be made. Bateson discovers (*ante*, pp. 420-421) distinct differences between the genitalia of *A. filipendulae*, *A. trifolii*, *A. viciae*, *A. exulans* and *A. purpuralis*, yet he fails to distinguish those of *A. lonicerae* and *A. trifolii*, and *A. filipendulae* and *A. hippocrepidis*, Stephs. A distinction in the genitalia of *A. filipendulae* and *A. lonicerae* has not been sufficient to prevent Fletcher from obtaining hybrids between these insects, nor Standfuss from successfully crossing *A. filipendulae* with *A. trifolii*. We have left for consideration, then, the habits of the insects, their relation to their environment, their specialisation to their food-plants, and similar factors which have caused them to take on those characters which, in the mass, make us consider them as species. We are not in a position to satisfactorily deal with the effect of environment on the fixity of specific characters, yet a few considerations may be useful. The Anthrocerid, which is best known to us as having a very specialised environment, is *A. exulans*. It is an alpine and arctic species, apparently incapable of carrying on its existence apart from a long and severe winter, and an alpine flora. It haunts the marshes at the sea-level along the shores of the Arctic Ocean, in Russia and Finmark. As we come south it gradually leaves the lowlying land, following the gradually increasing altitude to which the arctic (and alpine) flora is restricted, and reaches up the mountains of Scandinavia and Finland as far as plant-life can exist. In southern Scandinavia and Scotland it is rarely found below 1,500 ft.-2,000 ft. above sea-level, and as we go south, the altitude at which an alpine flora is found continually increases, until in the Pyrenees, the Alps of central Europe, and the huge mountain chains of central Asia, it never occurs at a lower elevation than from 5,000 ft.-6,000 ft. *A. exulans* is distributed over almost the whole of these ranges, in districts separated by thousands of miles by lowlying land in which the species is never found. We have only to reach a certain height to make sure of finding this insect, slightly changed it may be, according to the district, but still undoubted *A. exulans*, never coming below these comparatively barren regions of the high alps, but going as high as vegetation can be found to support the larvæ. Here, then, we have one of the most specialised of the Anthrocerids, so far as its environment is concerned, and here we have (except within certain very narrow limits) one of the most constant, its constancy probably due to its isolation through an almost incalculable period, for when an insect occurs practically unchanged in the mountains of Scandinavia, Scotland and France, the Pyrenees, the Alps, and the Altai, confined to a certain elevation, and absent from all the intermediate grounds, which are of immense extent, we must conclude either (1) that the species existed in its present form at a time when the whole of the intermediate areas were suited to its existence, and subsequent climatic changes have driven it into still suitable places, or (2) that in common with many other species, it was able to exist in the lower lands under different climatic conditions, and that the competition for existence being less severe, it retreated into those districts which it now occupies, where the stress of its organic environment is less potent, the insect being slowly modified to become fitted to its new surroundings, and at last defied almost the whole insect fauna to follow it. That it is suited to its environment is certain, for in the most inhospitable regions *A. exulans* is to be sometimes seen, literally in millions. Both these theories assume that *A. exulans* existed in the lowlying lands, and if this were so, the species must have taken on its present form before the British Islands were separated from the continent of Europe, and probably before the great break, which now separates the great mountain-chains of Asia from those of Europe, occurred in the neighbourhood of the Caspian and Ural Seas. If, however, we accept either of these theories, and suppose that not *A. exulans*, but a progenitor of the species, inhabited the lower ground, we have the remarkable fact that this ancestor has developed into a practically identical form over a vast area of the world, and maintained a particular facies in all the different directions in which the specialisation of the species is going on.

In *Anthrocera purpuralis* we have a species that is not strictly limited by altitude or latitude, nor by an arctic or sub-arctic flora. It occurs at the sea-level in Scotland, Ireland, Scandinavia, Russia, Germany, France, Switzerland, Austria, Turkey, Greece, Italy, Asia Minor and Central Asia. It extends from the sea-level, through all intermediate elevations, until it has reached 7,000 ft.-8,000 ft.—Mont de la Saxe 7,000 ft., Cogne 6,500 ft., Le Lautaret almost 8,000 ft., Heiligenblut 7,000 ft., Kokand district 7,000 ft., and the defile of Chakhisnarden, in the Pamirs. Wide as is its distribution, however, there is a roughly governing factor, the species is rarely found off a calcareous soil, and if it be, it is usually near enough to show traces of the characteristic flora of chalk and limestone districts. The difference between this environment and that of *A. exulans* is perceptible at once. The latter is confined to the summits of high mountains, or to high latitudes, where the stress of the organic environment is reduced to a minimum. The environment of the former extends from sea-level to 7,000 ft. or 8,000 ft., and the insect is subjected to an organic environment differing as greatly as the fauna and flora of Italy and Greece, the west coasts of Great Britain and Scandinavia; it is subjected to a climatic environment differing as greatly as the hot plains of southern Italy and Asia Minor, the wet west coasts of Britain and the cold of the highest Alps of Dauphiné, Piedmont, Switzerland, Carinthia and the Pamirs, where winter lasts for at least eight months in the year. Under such varying conditions, local races differing in size, scaling, and general appearance are produced, whilst a number of separate forms—*erythrus*, *rubicundus*, *brizae*, etc.—appear to have been developed from this species along the shores of the Mediterranean, where the stress of the organic environment is probably at its greatest. How far are *heringi*, *pluto*, *nubigena* and *polygalae* distinct species? Experts have so considered them, and yet we are inclined to conclude that the sum total of characters is insufficient to give them specific rank. Quite recently Calberla has shown that the male genitalia of *rubicundus* are fixed, and on this one character we are constrained to consider it a species apart from *purpuralis*, of which it had previously been considered a local race. So little is necessary to change the opinion of lepidopterists as to whether an insect is a local race or distinct species.

What conditions led to the specialisation of the genitalia of *rubicundus* in a certain direction, so that they became constantly different from those of the stem form?

We may now consider *A. viciae*, better known under its synonym of *meliloti*. The distribution of this species is remarkable, extending from Barbary to Scandinavia, and from the New Forest (its most western limit), throughout Europe and Asia to Dahuria and Amurland. It is local, occurring generally in great abundance in limited districts, of which our New Forest locality may be considered an almost typical one. It haunts borders of woods and wood-clearings, but what limits it to these districts has yet to be discovered, nor can we suggest a cause. Are the reputed food-plants not the natural ones? Is it confined to a special species of plant that extends locally over all its range? We do not know, yet it should not be difficult to discover. Over such an area the conditions of environment must be extremely varied, yet under somewhat similar conditions the same form (the one we know so well) is maintained, the specimens from Germany, France, the Baltic provinces and Asia Minor, being almost identical with our British examples. By the time the insect has reached its most northern and western limits, some degree of variation is noticed; the thin scaling is maintained, the general facies is little altered, but the hind-wings show an increase in the width of the marginal border, and the red colour is reduced to a minimum. These appear to be the only essential differences, yet they have a marked effect on the general appearance of the insect. In Finland this race is known as *ehnbergii*, in Amurland as *dahurica*. An occasional British specimen will show a few red scales on the abdomen, a suggestion of an abdominal ring in embryo. In Pomerania and the Baltic provinces similar examples are found, whilst an occasional specimen will have the ring almost complete, forming the ab. *stentzii*. In Roumania, where the insect is very abundant, a strange development occurs, for typical *viciae* are here mixed with individuals which Caradja is unable to separate from *dahurica*, whilst the red-ringed form is by no means rare. Occasionally, in Britain, and in the localities of north and central Europe, an example is found with the spots 1, 2 + 4, 3 + 5, forming three wedge-shaped streaks, as in *A. purpuralis*, but the aberration is exceedingly rare. In the Ala Tau district this is the common form, and Staudinger has termed the local race *confusa*. So far, however, these local races differ but little radically, and in general appearance, from the type. In the warm, southern, transalpine valleys, however, a change occurs. *A. viciae*, as we know it, appears to be almost unknown, but in its place we have an insect thickly scaled with brighter red markings, with a very characteristically marked marginal border to the hind-wings, and with a tendency to develop a strongly marked and brightly coloured red abdominal belt. In addition, this form has spot 6 developed, not strongly in all specimens, but as well-developed, say, as is the corresponding spot in the south-alpine forms of *A. ochsenheimeri*. This insect is the *charon* of Hübner, and even on superficial grounds one feels inclined to say at once that it is a distinct species. Calberla, however, has come to a different conclusion, and considers it simply a transalpine form of *A. viciae*, although at present he has published no critical comparative life-histories of the two insects, which alone can determine the matter. It might be supposed that the presence of the

6th spot would settle the specific distinction of *charon*, but Fletcher, Christy, and others, possess British specimens of *A. viciae* with spot 6 more or less well-developed. If *charon* be really a transalpine race of *A. viciae*, then the climatic conditions, and the more nutritious food of the southern countries, are possibly the factors that have determined the great superficial differences that exist between our *A. viciae* and the *charon* dwelling beyond the Alps.

A. lonicerae is the most constant, *A. trifolii* the most variable, of all our British species, the former probably the most constant in the character of its environment, the latter the most variable. Bateson is unable to separate *A. lonicerae* and *A. trifolii* by their genitalia, yet one can determine the larvæ and imagines readily enough, and the similarity of the genital organs is emphasised by the fact that the two species hybridise freely *inter se*, and produce fertile progeny. Here, then, the specific difference is not due to a specialisation of the genital organs, but must be due to isolation in some other form. To a certain extent isolation may be brought about by a difference in time of appearance, for *A. lonicerae* is decidedly later than *A. trifolii* in the normal time of its appearance, and earlier than *A. palustris*. The specialisation to a certain food-plant may be potent, although as yet insufficient attention has been paid thereto, and it is quite possible that *A. palustris* is specialised from *A. trifolii* by being limited to *Lotus uliginosus*. Both *A. lonicerae* and *A. trifolii* present many interesting phases in the question of species on the continent, the former in its relation to *A. medicaginis*, the latter in its relation to *A. palustris* and the extreme form of the latter, *A seriziati*. *A. trifolii* presents us, as we have already seen, with two distinct races in Britain, *A. trifolii* and *A. palustris*, already dealt with at length, distinct enough in their extremes, and clearly responding to their environment. The small meadow and hillside form prefers a dry habitat, appears in June (sometimes in May), which suggests that the nature of the habitat governs, to some extent, the time of its appearance. It has a less succulent food-plant (*Lotus corniculatus*), and probably as a result it is of smaller size, rather less brilliant tint, and has generally a wider marginal band to the hind-wings. The larger marsh form prefers a moist habitat, and appears in July and August, it has a more succulent food-plant (*Lotus uliginosus*), is of larger size, more brilliant tint, rather narrower marginal band to hind-wings, etc. In their extremes, therefore, the insects are distinct enough, and the nature of their respective habitats, with the resulting isolation as to time of appearance engendered thereby, appear to be sufficient to bring about a very definite separation. Intermediate conditions possibly do prevail, and the extremes appear to be united by overlapping forms, so that it is difficult to consider them as species. Here, then, is a distinct factor that weighs in the determination of species, *viz.*, the positive separation of distinct forms or races (by their environment, etc.), *e.g.*, *lonicerae* and *trifolii*, the union of otherwise distinct races (with a different environment) by intermediate forms (with an intermediate environment). Yet the strongly-marked larva of *A. trifolii* is as different in appearance as possible when compared with the pale, scantily-marked larva of *A. palustris*. We are not prepared to enter into the effect of the wider geographical conditions to which *A. trifolii* is subjected, for, with the exception of the French lepidopterists, it is doubtful whether any of the continental lepidopterists have any very clear view as to the differences between *A. trifolii* and *A. lonicerae*, and it would be absurd to attempt any generalisation upon unreliable data. One may add, however, that in Algeria, both *A. trifolii* and *A. palustris* maintain their characteristic habits and habitats. *A. syracusia* represents our *A. trifolii*, and in Algeria is almost indistinguishable from it; *A. seriziati* represents *A. palustris*, and is marvellously modified in the blue colour of the fore-wings and in the border of the hind-wings, which sometimes occupies almost the whole wing. Whether or no one would maintain the specific identity of British *trifolii* and *palustris*, he would be a bold man who would unite specifically the Algerian *A. syracusia* and *A. seriziati*.

One other species remains for consideration, *viz.*, *A. filipendulae*. This has a great range in Europe, although almost unknown in Asia (exclusive of Asia Minor). It extends from the north of Scandinavia to the Mediterranean Sea, and reaches to a considerable height up the mountains, from 6,000-7000 ft. in the central Alps. We have not merely, however, alpine and lowland forms, for the former, although specialised in the direction of thinner scaling and duller coloration (and the race from the Alps, var. *mannii*, is similar to that from Finmark, var. *arctica*, in these respects) resembles the lowland type, more than do some of the lowland forms each other. We have, in England, two of the best-marked forms, or races, that the insect presents, *viz.*, the early (May and June) meadow form known as *hippocrepidis*, Stephs., and the ordinary later (July and August) form *A. filipendulae*. In many ways these are exactly parallel with *A. trifolii* and *A. palustris*, respectively, *hippocrepidis* being earlier, smaller in size, the red spots much reduced, the marginal border of the hind-wings broader, whilst the *filipendulae* of our hills and waste places often presents us with somewhat intermediate forms between these and the large, late specimens we obtain on our coast cliffs and marshes. The origin of *A. hippocrepidis*, Stephs., is uncertain. As we have pointed out, it is often a meadow species like the early *A. trifolii*, and frequently occurs therewith, appearing in the imaginal, whilst typical *filipendulae* is still in the larval, state. The specialisation in spotting is most marked, the males having the 6th spot reduced, and occasionally entirely absent, when it is quite indistinguishable from *A. trifolii*. We understand that M. Dupont captured examples of *hippocrepidis*, Stephs., in 1898, near Le Havre, strangely enough with early *A. trifolii*. Two questions arise—Is *A. hippocrepidis*, Stephs., a distinct species? Is it more closely related to *A. trifolii* or *A. filipendulae?* Bateson examined the genitalia of some of our best examples of *A. hippocrepidis* (one distinctly *A. trifolii* in size, shape, colour, and spotting), and reported them as undoubted *filipendulae*. Yet its life-history and cycle of existence are perfectly distinct from those of *A. filipendulae*, and there is no great similarity in the imagines, except that a large percentage have six spots, an almost unfailing condition in *A. filipendulae*. The life-histories want working out critically, and, if possible, all stages compared by an expert, before a final conclusion can be reached. We have been unable, on the strength of our field observations, to come to any other conclusion than that *A. hippocrepidis* is a near ally, if not direct offshoot of *A. trifolii*. Our reason for this supposition is that we have seen a well-known locality for *A. trifolii* gradually fail for this species, whilst the same ground has become remarkable for the abundance of *A. hippocrepidis*. It may be, of course, that two distinct species have occupied for a considerable time the same ground, and that what we have observed has been simply a natural fluctuation in relative abundance and scarcity. Still, we cannot forget that we have seen hundreds of *A. trifolii* in these fields, with here and there a six-spotted *hippocrepidis* among them, that of late years *trifolii* has disappeared, and that *hippocrepidis* has taken its place, whilst the extreme males of *hippocrepidis* are still almost indistinguishable superficially from *A. trifolii*. All these difficulties face one in the study of the Anthrocerids, and still one asks, as yet in vain, What is a species? The specialisation of *A. hippocrepidis* males is exactly parallel with that of *A. ochsenheimeri*, a fine race occurring in the southern Alps, richly coloured and thickly scaled, but with the 6th spot reduced in the males often nearly to vanishing point. [This is exactly the opposite result to that occurring in *A. viciae* where, in the assumed transalpine form, *charon*, Hb., a 6th spot is developed.] Yet the female *ochsenheimeri* is indistinguishable from many typical *filipendulae*, and the same is true of female *hippocrepidis*, Stephs. The life-history of the latter is still unpublished (and practically unknown); it may be identical with *A. filipendulae*, it may be very different therefrom. Our ignorance makes us form opinions, and opinions based on ignorance are always bad. One feels, however, that it is better to keep all these forms distinct rather than lose them by a lumping process that is bad in itself and unscientific in principle. One other point is worthy of mention. We forwarded to Fletcher, in 1894, ♀ *ochsenheimeri* and eggs, from Courmayeur. Some of those bred in 1895 were characteristically marked with a small 6th spot. The most extreme forms in this direction were crossed, and in 1896 others with spot 6 almost absent were obtained. In 1897, and 1898, careful selection and inbreeding had got rid of spot 6 altogether, and an artificial 5-spotted form had been obtained. These, although very similar in appearance to the 5-spotted *A. lonicerae*, refused to pair therewith, but paired freely with *A. filipendulae*, of which *A. ochsenheimeri* appears to be only an alpine variety. That is, Fletcher's examples appear to have maintained the separate genitalia of *A. filipendulae*, whilst spot 6 has been suppressed, and a race produced superficially resembling the 5-spotted species. We should like to have compared actual specimens of *gurda* and *mersina* with Harwood's Essex aberrations, but the continental material was not forthcoming, and this remains among the problems for future investigation.

The old notion that species should breed true fails utterly when applied to the Anthrocerids. Some hybridise freely, and cross-pairing occasionally takes place in the most erratic manner (*ante*, pp. 418-419). It is clear that some well-defined Anthrocerid species that inhabit the same ground are able to pair, if so disposed, and produce fertile progeny, yet the species are maintained pure in their breeding-grounds, often five or six species occurring in a very restricted habitat. Inability to cross can, therefore, hardly be considered a test of species among the Burnets, and if this were taken as a test, we should perhaps have to reduce our European species to something less than a dozen, and yet, while quite able to cross, they rarely do so in nature, so far as our observations go. The species are generally well-defined in colour and markings, and the variation of each takes its own lines, so that difficulty of separation is rarely experienced in this direction. What, then, must be the criteria of species here? What keeps the species pure, when they could so readily intercross? We do not know, but we imagine that the specialisation of the male abdominal scent glands helps them to select their own mates, and that this is aided by the isolation of the imagines by certain habits, by the specialisation of the larvæ to certain food-plants, and similar factors of equal importance. When, therefore, a race has become sufficiently specialised by habit, habitat, food-plant, or similar cause, to maintain itself as a distinct form, definable structurally by some peculiarity of colour or distribution of markings, that race has in our opinion attained specific rank, and should be so treated. That it should exhibit a marked difference in egg, larva and pupa also, is hardly to be expected, except as a result of long-continued isolation, and there is no reason why the genitalia of a group should not be as generalised as the neuration. Specialisation in other directions than the early stages—antennæ, neuration, genitalia, etc.—must be looked upon as of the greatest importance in a group like this when it does occur, but these must not be considered as the only criteria in the determination of Anthrocerid species.

ADDENDA.

p. 369. *Cochlidion avellana*, Linné.—In accepting *avellana*, Linné, as the specific name for the insect more generally known as *limacodes*, Hufn., or *testudo*, Fab., we followed Kirby and Werneburg. Grave doubts as to whether *avellana*, Linné, referred to the species in question, were raised when we entered into the matter more fully, and we are now informed by Prout that the insect in the Linnean cabinet that bears this name is a Tortricid moth. We know that the insects in this cabinet are not as Linné left them, still, in the present uncertainty, we think it advisable to add Hufnagel's description. This reads as follows:—

> *Phalaena limacodes.*—Die Schildmotte. Bräunlichgelb mit 2 braunen Querstreifen, die Unterflügel etwas brauner. Raupe, glatt, kurz und dicke. Hat die Figur eines Schildes; grün mit rothen und gelben Streifen. Auf den Eichen und Büchen; September. Vogel. an den Blättern der Bäume; Mai und Junius. Von der vierten Grösse. Selten [*Berl. Mag.*, iii., p. 402 (1766)].

Hufnagel adds (*loc. cit.*, p. 425) that when he first found the larvæ he took them to be those of *Zephyrus betulae*, until they made a round, red-brown, very dense cocoon on the ground. The pupa, he notes, had a very thin shell, and the position of the mouth-parts stood out strongly. He concluded that it was likely that some species of fly or wasp would be developed from them, but in the spring, *Phalaena limacodes* appeared, the male smaller and darker than the female. He adds that much as the larva superficially resembles that of *Z. betulae*, it differs in having a short, lateral, bright, rose-red stripe on each segment, whilst the yellow, oblique, lateral lines are wanting, and the ventral area is covered with many pale yellow spots.

p. 470. *Anthrocera medicaginis*, Bdv.—Under the name of *A. dubia* ab. *confluens*, Oberthür figures a form of this insect. He writes: "*Anthrocera dubia* ab. *confluens*, Oberth., "Études," etc., xxth. livr., pl. viii., fig. 147."—This figure shows a specimen of *medicaginis*, Bdv., with an extra spot between 3 and 5, and a slight inner extension of 5 towards the extra spot. From Vernet-les-Bains.

ERRATA.

p. 15, line 23, for "Catocalia" read "Catocalid." p. 183, line 2 from bottom, for "*tengstormi*" read "*tengströmi.*" p. 416, line 13, for "*paludis*" read "*palustris.*"

INDEX.

PAGE

abdominalis (= linearis), Macrocentrus 526
abietaria, Boarmia 14
abietis, Dasychira 15, 16
abruptaria, Hemerophila 7, 11, 64, 66, 88, 89
absynthiata, Eupithecia 86
acerella (= sericopeza), Nepticula 343
aceris, Apatela 11
aceris, Nepticula 166, 172
acetosae, Nepticula 251-253, 259, 273, 276, 303
acharon, Adscita (Zygæna) ... 384
achilleæ, Anthrocera 417, 418, 424, 425, 436, 460, 519
achilleae (lonicerae *ab.*), Anthrocera 468, 469
achilleae (purpuralis), Anthrocera 431
achine, Pararge 13
Addenda 546
Addenda to Nepticulids 354
Adela... 3
Adelides 109
adippe, Argynnis 15
Adoneta 123, 361, 363
Adscita (= Anthrocera) 415
Adscita (Procris) 384, 385, 386, 387, 388
Adscitidi 385, 386
Adscitinae (Procrinae) 383, 384, 385, 386
Aeacis (= Anthrocera) 415
aeacus (peucedani *ab.*), Anthrocera 422
aegon, Plebeius 8, 14, 98
aeneella, Nepticula 189
aeneofasciata (= aeneofasciella), Nepticula 224
aeneofasciella (= aeneofasciata), Nepticula 164, 165, 168, 224-226, 227, 228
aescularia, Anisopteryx 12, 13, 37
affinis, Calymnia 39
Agaristidae 107
Agdistis 48, 114, 115, 118, 119, 121
aglaella, Micropteryx 130, 138, 157
aglaia, Argynnis 66
Aglaope 384
Aglaope (= Adscita) 388
Aglia 51, 120
agrimoniae, Nepticula 163, 165, 171, 179, 225, 313-314
agrimoniella (=agrimoniae), Nepticula 309, 311, 313
Agrumenia (= Anthrocera) ... 415
albifrons, Symmerista ... 91, 92
albiguttatus, Cochlidion (Apoda) ... 368
albovenosa, Pharetra (Arsilonche) 11
albulata, Emmelesia 65

PAGE

algeriella, Micropteryx 138, 157, 159
allionella (= aureatella *var.*), Micropteryx 130, 152, 155, 156, 157, 158
alnetella, Nepticula 165 172, 263-265, 270, 283, 284
alni, Jocheaera ... 49, 50, 78, 97
alniaria (tiliaria), Ennomos ... 15
amasiella, Micropteryx 138
amataria, Timandra 14
americana, Apatela 49
americana, Gastropacha 49
ammanella, Hb. (= anderschella, H.-Sch., *nec* Hb.), Micropteryx 136, 138, 157
ammanella (= aureatella), Micropteryx 156, 157
ammanella (= mansuetella), Micropteryx 152
amoenella (= aureatella), Micropteryx 156
ampelophaga, Adscita ... 387, 390
Amphientomum 3
Anagnia 48
analis, Pezomachus 526
Anatolis 388
anceps (? geryon *var.*), Adscita 401, 402
anderschella, Micropteryx 133, 134, 135, 137
anderschella (= thunbergella), Micropteryx 154
angelicae, Anthrocera (Thermophila) ... 415, 470, 472, 515
anguina, Dasylophia 41
angulifasciella, Nepticula 164, 165, 170, 171, 172, 175, 179, 268, 304, 305, 306, 307, 308-310, 311, 312, 313, 314, 324
angusticolella, Tischeria 58
Anisota 40, 48
annulata, Hydrusa (Zygaena) 383
annulata (omicronaria), Zonosoma 84
annulata (viciae *var.*), Anthrocera 457
anomala (= anomalella), Nepticula 206
anomalella, Nepticula 163, 165, 169, 174, 179, 183, 187, 192, 198, 204-211, 212, 213, 215, 243, 268
Anomalon 98, 413
Anthilaria (= Anthrocera) ... 415
Anthrocera 50, 117, 118, 383, 384, 386, 387, 388, 389, 414-415
Anthroceridae (Zygaenidae) 107, 114, 116, 117. 385
Anthrocerides 109, 115, 117, 383, 38
Anthroceridi 386, 414

PAGE
Anthrocerinae 383, 384, 385, 414
anthyllidis (triptolemus). Anthrocera (Lycastes) 416
antiqua, Orgyia 10, 15, 27, 28, 38, 59, 100
Apatelae 49
Apatelidae... 111
apicalis, Cochlidion (Apoda) ... 368
apicella (= argyropeza), Nepticula 323, 328, 330
apiciaria, Epione 14, 15
Apoda (= Cochlidion = Limacodes) 120, 180, 360, 361, 364, 368
Apodidae 360
apollo, Parnassius 15, 101
aprilina. Dichonia 13
archippus, Anosia 93
arctica (= filipendulae *var.*), Anthrocera 515, 544
Arctiidae 107, 111
Arctiides 28, 38, 109
arcuata (= arcuatella), Nepticula 304, 305, 306, 314
arcuatella, Nepticula 165, 178, 306-308, 309, 313
arcuosella (arcuatella), Nepticula 306
arenacea, Cochlidion (Apoda) ... 368
argentata, Hepialus 135
argentiflua, Leucophobetron ... 366
argentipedella, Nepticula 166, 172, 173, 175, 179, 184, 276, 289-291, 292, 293, 298, 308, 309, 327, 344
argentipedella (= woolhopiella), Nepticula 292
argiolus, Cyaniris 98
argus, Plebeius 96, 98
argyropedella (argyropeza), Nepticula 327
argyropeza (= apicella), Nepticula 166, 168, 172, 177, 179, 183, 327-330, 341, 344, 348, 350
argyropeza (= subapicella), Nepticula 330
argyropezella (argyropeza), Nepticula 327
argyrorrhoea, Leucophobetron ... 336
argyrostigma (= headleyella), Nepticula 33
Arichalca 385, 415
aries (= filipendulae), Anthrocera (Adscita) 388, 508
Arniocera 415
arthemis, Basilarchia 98
aruncella (= podevinella), Micropteryx (Eriocephala) 1, 129, 130, 133. 137, 138, 139, 145-149, 150, 151
aruncella (= seppella), Micropteryx 149
Ascalaphus 135
asella (= avellana *ab.*). Cochlidion 370
asella (us = cruciata), Heterogenea 181, 375
asellana (= cruciata), Heterogenea 378
assimilella, Nepticula 166, 350-352
atlas, Attacus 48
atricapilla (? aruncella *var.*). Micropteryx 138, 148
atricapitella, Nepticula 165, 183, 185-187, 188, 189, 192, 197, 198, 216, 219
atricapitella (= ruficapitella), Nepticula 187
atricollis, Nepticula 164. 165, 171, 304-306, 307, 309, 314
atrifrontella, Trifurcula ... 358
atropos, Acherontia 29
Attaci 128
Attacinae 51, 123
Atychia (= Adscita) 388
Atychia (= Rhagades) 406
aucupariae, Nepticula 165, 189, 195-197
auge, Cosmosoma (Zygaena) ... 383
aurago, Tiliacea (Xanthia) 12, 13, 15
aurantia (filipendulae *ab.*), Anthrocera 510, 511
aurantiaria, Hybernia 66
aureatella. Micropteryx 130, 133, 137, 138, 152, 155, 156-160
aurella, Nepticula 163. 164, 165, 174, 184, 225, 228-233, 242, 243, 244-247, 254, 260, 268, 278, 309
aurella (= gratiosella), Nepticula 253
aurella (? = ignobilella), Nepticula 278
aurella (= marginicollella), Nepticula 260, 261, 278
auricoma, Pharetra (Acronycta) ... 11
auricrinella, Epimartyria 137, 138
aurinia *var.* merope, Melitaea ... 70
auromarginella, Nepticula 165, 242-243
auropulverella, Micropteryx ... 138
australis, Aporophyla 39
australis (= syracusia), Anthrocera 489
autumnaria, Ennomos ... 13, 14
avellana(= limacodes = testudo), Cochlidion 37, 77, 116, 117, 135, 360, 363. 364, 365, 366, 367, 368, 369-377, 378. 380, 381, 389, 412, 546

ballus, Thestor 98
basalella, Nepticula 165, 172, 178, 179, 184, 297, 299-302, 306, 354
basalis (trifolii *ab.*), Anthrocera 418 425, 485, 487
basiguttella, Nepticula 165, 173, 217-220
bellidis (bellis), Anthrocera (Lycastes) 416
bembeciforme, Trochilium ... 12
berberata, Anticlea 16
berolinensis (carniolica *ab.*), Anthrocera 424
berytella, Micropteryx 138
betulae, Zephyrus 68, 546
betularia, Amphidasys 12, 44, 81, 84, 87, 88, 89

PAGE
betulicola, Nepticula ... 165, 179, 249, 268, 269-272, 273, 280, 281, 282, 286, 303
Bibionidae 2
bicolor, Rhogas 526
bicolor, Sphingicampa 125
bifida, Cerura 40
biguttata, Cochlidion (Apoda) ... 368
bilineata, Camptogramma ... 65
bilunaria (illunaria), Selenia 14, 15, 84
bipunctaria, Eubolia 66
bipunctata (filipendulae *ab.*), Anthrocera 509, 512
bistortata, Tephrosia 9, 12, 13, 16
bistrigella, Phylloporia (= subammanella, Tinea) 130
bistrimaculella, Nepticula 166, 184, 354
bitorquata (achilleae *ab.*), Anthrocera 423
biundata, Heterocampa 48
Blattidae 2
Bohemannia (= Scoliaula) ... 359
Bombycidae 105, 107, 111
Bombycides ... 29, 38, 109, 115
Bombyx (= Cochlidion) 368
Bombyx (= Heterogenea) 377
boreata, Cheimatobia 15
brachydactylus, Pselnophorus 121, 126
Brahmaeidae 105
brassicae, Pieris 59, 60
Brephidae 111
Brephides 109
Brephos 8
brizae, Anthrocera (Mesembrynus) 416, 417, 424, 425, 458, 541
brumata, Cheimatobia ... 10, 15
Bryophila 63
bucephala, Phalera 38, 60
budensis, Adscita 387
bufo (avellana *ab.*), Cochlidion ... 370
buglossi (viciae *ab.*), Anthrocera 454, 457

caerulea (geryon *ab.*), Adscita ... 401
caerulea (globulariae *var.*), Rhagades 408
caerulea (trifolii *ab.*), Anthrocera 484
caeruleocephala, Diloba (Episema) 26, 27, 28, 38
caesia, Dianthoecia 65
caesiata, Larentia 14
caffra, Neurosymploca (Zygaena, Eutychia) 383, 415
caia, Arctia ... 13, 14, 27, 28, 42
Calamorceras 161
c-album, Polygonia ... 11, 12
Callosamia 51
calthella, Micropteryx (Eriocephala) 1, 104, 129, 130, 133, 136, 137, 138-145, 149, 150, 152, 153, 155, 158, 159, 162
calthella (= seppella), Micropteryx 149
Calybia 364
cancriformis, Apus 24
capistrata, Syntomerata (Zygaena) 383
capitella, Incurvaria (Lampronia) 36

PAGE
Carabidae 77
cardamines, Euchloë ... 10, 63
cardui, Pyrameis 14, 441
carmelita, Odontosia 38
carniolica, Anthrocera 415, 416, 419, 423, 424, 442, 479
carpinella (= ? fagi), Nepticula ... 316
carpophaga, Dianthoecia ... 38, 39
cassandra, Saurita (Zygaena) ... 383
casta, Arctia 27, 28
casta, Doratifera 98
casta (nitidella), Fumea (Psyche) 27, 28
castanella, Nepticula 165, 183, 302
Castniides 109
castrensis, Clisiocampa (Malacosoma) 9, 12
catenatus, Cochlidion (Apoda) ... 368
catharticella, Nepticula 166, 172, 337, 339-340, 341
Catocala 89
cecropia, Platysamia ... 22, 34, 59
centifoliella (= marginicolella), Nepticula 260
centifoliella, Nepticula 165, 183, 184, 204, 211, 261, 267-269, 273, 303
centripuncta (lonicerae *ab.*), Anthrocera 468
Cerambycidae 39, 43
Ceratocampa 125
Ceratocampidae (Citheroniidae) 40, 48, 103, 105, 112, 124, 125, 128, 129
Ceratomia 125
cerbera, Zygaena 383
cerinus (= filipendulae *ab.*), Anthrocera 513
Cerura 40, 41, 49, 92, 93, 96, 102
cervinata, Ortholitha 51
chalcophanes, Palaeomicra 138, 161, 162
Chalcosia 48
chalybea (lonicerae *ab.*), Anthrocera 423, 468, 469
charon (Bdv. *nec* Hb.), Anthrocera 470, 516
charon, Hb., (? viciae *var.*), Anthrocera 415, 455, 456, 458-460, 468, 520, 539, 542, 543, 545
charon (= medicaginis), Anthrocera 470, 516
Chelonias (= Cochlidion) 368
Chelonias (= Heterogenea) ... 377
chi, Polia 15, 39
Choerocampa ... 48, 92, 127
Choerodes 40
christophi, Anthrocera 460
christophi, Cochlidion (Apoda) ... 368
chrysanthemi (filipendulae *ab.*), Anthrocera 423, 437, 468, 487, 511, 514
Chrysaor (= Adscita) 387
chrysargyra, Palaeomicra 138
chrysocephala (geryon *var.*), Adscita 387, 390, 400, 401, 404
chrysorrhoea, Porthesia ... 13, 100

PAGE
cilipeda, Phorocera 477
cingulata (? viciae *ab.*), Anthrocera 458, 459
circellaris (ferruginea), Mellinia ... 12
Citheronia 40, 51
Citheroniidae 107
citrinus (filipendulae *ab.*), Anthrocera 513
clara (exulans *var.*), Anthrocera 446, 447, 448
clathrella, Solenobia ... 27, 28
Cleora 63
Clisiocampa 58, 76, 124
Cnethocampa 76, 115
Coccinellidae 37
Cochlidae 360
Cochlidia 360, 368
Cochlidiae (Eucleidae) 107, 116, 360
Cochlididae (= Limacodidae = Eucleidae) ... 114, 360, 365
Cochlidides (Eucleides) 109, 115, 117, 360
Cochlididi 368
Cochlidinae 365, 368
Cochlidion (= Limacodes) 360, 364, 365, 368, 378
Cochliopoda (= Cochlidion) ... 368
Cochliopoda (=Heterogenea) ... 378
Cochliopodae (= Cochliopodidae) 360
Cochliopodi (= Limacodes) ... 360
Cochliopodidae (=Eucleidae) 103, 123, 129
Cocliopodes (*rect.* Cochliopodes) ... 360
codeti, Cochlidion (Apoda) ... 368
coenosa, Laelia 28
cognata (?globulariae *var.*), Rhagades 408, 413
Coleophora 51
Colias 9
comes, Triphaena 39
comma, Pamphila 15
communimacula (filipendulae *ab.*), Anthrocera 510, 512
complana, Lithosia 126
completella, Micropteryx 138
concinna, Schizura ... 91, 93
concinnella (= aruncella), Micropteryx 146, 150
concolor, Cochlidion (Apoda) ... 386
concolor, Lymantria 97
concolorella (= cristatella), Bucculatrix 220, 221
confertella, Trifurcula 355
confluens (dubia *ab.*), Anthrocera 546
confluens (filipendulae *ab.*), Anthrocera 509, 512
confluens (trifolii *ab.*), *vide*, minoides, Anthrocera ... ...
confluens (viciae *ab.*), Anthrocera 456
confusa (viciae *var.*), Anthrocera 456, 458, 542
confusella, Nepticula 166, 282, 294, 295, 296, 297
conjuncta (filipendulae *ab.*), Anthrocera 510, 512
conspersa, Dianthoecia 65

PAGE
continuella, Nepticula 166, 237, 238, 265-267, 292
convergens, Cochlidion (Apoda) ... 368
convolvuli, Sphinx... ... 103, 125
coronillae (ephialtes *ab.*), Anthrocera 422
Corydalus 132, 135
corydon, Polyommatus ... 8, 96
coryli, Demas 38
Cossidae 2, 106, 107
Cossides 109
Cossus 43, 106, 108
Crambides 63
Crambus 36
Crameria 388
crassicornis (? statices *var.*), Adscita 391, 392
crataegi, Trichiura... 14, 15, 38, 119
crenulella, Apterona (helix, Psyche) 26, 27, 28
crepuscularia (biundularia), Tephrosia 9, 12, 64
creusa, Euchromia 383
crispata, Lagoa 37, 103, 119, 123, 126, 361, 365
cristatella, Lyonetia 355
cruciata (asella), Heterogenea 37, 77, 168, 363, 366, 367, 368, 378-383
cryptella (= eurema), Nepticula ... 332
cryptella, Nepticula 166, 332, 333-335, 336
Ctenophora 3
cucubali, Dianthoecia 39
cucullata (sinuata), Anticlea ... 82
cucullatella, Nola... 38
Culex 3
Culicidae 77
culiciformis, Sesia 66
cultraria, Drepana 38
cuneata (lonicerae *ab.*), Anthrocera 468
Curculionidae 43
cursoriella (= subbimaculella), Nepticula 176, 184, 350, 352
Cymatophoridae 105
Cymatophorides (Thyatirides) ... 109
Cymbidae 107
cynarae, Anthrocera (Lycastes) 416, 417, 425
Cynipidae 4, 30, 177
cynthia, Samia 48
Cyrnus 161
cytisi (filipendulae *ab.*), Anthrocera 415, 509, 511, 512, 519, 520, 533
cytisi (hippocrepidis *ab.*), Anthrocera 533
cytisi (? lonicerae *ab.*), Anthrocera 468

dacica (viciae *var.*), Anthrocera... 457
Dactylopius 101
dahurica (viciae *var.*), Anthrocera 456, 457, 458, 542
dalbergiae, Dasychira 97
Danais 49
Dasychira 96, 97

PAGE
Dasylophia 51
Datana 51, 84
Debos 388
decentella (=sericopeza), Nepticula 171, 344
decipiens, Campoplex 526
declinator, Sagaritis 382
decora (? viciae *ab.*), Anthrocera 458, 459
decrepitalis, Scopula 9
defoliaria, Hybernia 64
Demas 96
dentatus, Cochlidion (Apoda) ... 368
depictella (= thunbergella), Micropteryx 154
desperatella, Nepticula 165, 189, 213-215
diadema, Epeira 24
diaphana (purpuralis *var.*), Anthrocera 434, 437
dictaea, Leiocampa 48
dictaeoides, Leiocampa (Notodonta) 28, 48
difficilis, Apanteles 526
dilutata, Oporabia 64
dimidiata (? basalella), Nepticula... 299
dimidiata, Pyromorpha 389
dimidiatella (= prunetorum), Nepticula 259
dimidiatus, Cochlidion (Apoda) ... 368
Dioptidae 105, 107
Diplectrona 161
diptera, Thyrassia (Zygaena) ... 383
dispar, Porthetria 13, 27, 28, 59, 60, 96
distinguenda, Nepticula 166, 171, 247, 266, 271, 280-283, 286
diversa (= obliquella), Nepticula 166, 323, 324
diversa (= ? salicis), Nepticula ... 317
dominula, Callimorpha 38, 54, 69
Doratifera 364
doroxena, Palaeomicra ... 138, 161
dorycnii, Anthrocera 456
doubledayaria (betularia, *ab.*), Amphidasys 63, 64
Drepana 76
Drepanidae 107, 109, 111
Drepanulides (Platypterygides) ... 109
Dryocampa 40
dubia, Anthrocera 539
dubia (? lonicerae *var.*), Anthrocera ... 470, 471, 472, 546
dubia (= medicaginis + ochsenheimeri), Anthrocera 509
dulcella, Nepticula 165, 183, 236, 237-237
dumolinii, Lophostethus 124

Eacles 40, 120
eboracae (lonicerae *ab.*), Anthrocera 467, 469
eburneigutta, Tinolius 49
egea, Polygonia 11
egeria, Pararge 13
ehnbergii (viciae *var.*), Anthrocera 458, 542
electa, Catocala 88, 89
elegans, Micropteryx 138
elinguaria, Crocallis 8, 44, 88, 89
elocata, Catocala 88, 89
elpenor, Choerocampa ... 91, 101
Empretia ... 77, 123, 361, 363
Endromides... ... ... 109, 115
Endromis 124, 125
Ennomos 8
Epermenia 109
Ephemera 60
ephialtes, Anthrocera (Aeacis) 383, 415, 418, 422, 428
Epicopeidae 105
Epimartyria ... 138, 160, 162
Epiplemidae 105
Eriocephala (= Micropteryx) 1, 5, 130, 138, 362, 373
Eriocephalidae 362
Eriocephalides (= Micropterygides) 1, 3, 6, 36
Eriocrania 338
Eriocrania (= Micropteryx) 104, 106, 132, 134, 135, 137, 162, ? 338
Eriocraniides (= Micropterygides) 104, 109, 110, 114, 131
Eriogaster 58, 76, 124
Errata 162, 354, 546
erythrus, Anthrocera (Mesembrynus) 416, 417, 424, 425, 436, 517, 539, 541
eryx, Belemnia 383
Euchloë 9
Euchromiidae 107, 111
Euclea ... 77, 361, 363, 364
Eucleidae (Cochlididae) 107, 360, 365
Eucleides (= Cochlidides) ... 360
Eucleinae 365
Eutychia (= Anthrocera) ... 415
Eulimacodes 364
Eulimacodinae 365
euphorbiae, Deilephila 47, 60, 82
euphorbiae *var.* myricae, Pharetra 10, 39
euphorbiella, Nepticula 334
Eupterotidae 105, 111
Eupterotides ... 109, 115, 123
eurema, Nepticula 332-333, 334, 335
excaecatus, Smerinthus 14
exclamationis, Charnidas 97
eximiella (seppella *var.*), Micropteryx 130, 138, 146, 149, 150
exoleta, Calocampa 39
exsiliens (exulans *var.*), Anthrocera 449
extensaria, Eupithecia 79
extrema (trifolii *ab.*), Anthrocera 485
exulans, Anthrocera (Lycastes) 416, 417, 421, 422, 423, 424, 427, 428, 430, 443-453, 540, 541

fagella, Diurnea (Diurnaea) ... 64
fagella (= fagi), Nepticula ... 316
fagella (= ? myrtillella), Nepticula 316

PAGE

fagi, Nepticula 178
fagi, Stauropus 80, 91, 92, 94, 101
fascelina, Dasychira ... 38, 96
fasciata, Arctia ... 15, 16, 68, 69
fasciellus, Nematois (Nemotois) ... 36
fasciola, Lithacodes 77
fastuosella, Eriocrania 135
fausta, Anthrocera (Hesychia) 383, 415, 417, 419, 422, 424
faustina, Anthrocera (Hesychia) ... 415
fenestrata, Thyris 383
Feniseca 101
ferrugana, Peronea (Tortrix) ... 20
festaliella, Chrysocorys 7
festucae, Plusia 39
filipendula (= filipendulae), Anthrocera 508
filipendulae, Anthrocera 121, 383, 387, 388, 415, 416, 417, 418, 419, 420, 421, 422, 423, 424, 425, 426, 427, 428, 429, 430, 431, 437, 438, 442, 444, 454, 460, 462, 463, 467, 468, 470, 472, 473, 475, 479, 481, 482, 483, 484, 494, 496, 497, 500, 502, 503, 507-532, 533, 537, 538, 539, 540, 544, 545
filipendulae, Cryptus 526
filipendulae (= hippocrepidis, St.), Anthrocera 532
filipendulae-major, Anthrocera 516, 517
filipendulae × lonicerae, *hyb.*, Anthrocera 419, 420
filipendulae × ochsenheimeri, *hyb.*, Anthrocera 420
filipendulae × trifolii, *hyb.*, Anthrocera 420
filipendulae, Nepticula 165, 183, 250-251, 276
filigrammaria, Oporabia 14
fimbria, Triphaena ... 12, 39
flava (achilleae *ab.*), Anthrocera ... 423
flava (exulans *ab.*), Anthrocera 423, 448
flava (filipendulae *ab.*), Anthrocera 422, 510, 513-514
flava (hippocrepidis *ab.*), Anthrocera 422
flava (sarpedon *var.*), Anthrocera 423
flaveola (carniolica *ab.*), Anthrocera 422
flavescens (cruciata *ab.*), Heterogenea 379
flavicinctata, Larentia 63
flavicornis, Asphalia 83
flavilinea (exulans *ab.*), Anthrocera 447, 448
fletcheri, Nepticula 165, 204-206, 208, 211-213, 216
flexula, Aventia 85
flexuosa, Heterogenea 77
floslactella, Nepticula 164, 165, 178, 276, 277, 288, 315, 318, 320, 321, 324-327
fluctuata, Melanippe 64
fluviata, Camptogramma 14
fossilis, Nepticula 181

PAGE

fragariella, Nepticula 165, 168, 183, 184, 232, 233-237, 238, 241, 242, 307
fraxini, Catocala 11, 89
freyella, Nepticula 313
frischella, Phalaena (Coleophora) 139
fulgens (= basalella = tityrella), Nepticula 297, 300
fulgens, Heterogenea 368
Fulgoridae 2
fuliginosa, Spilosoma 38
fulvia (lonicerae), Anthrocera 466, 467
fulvipes, Hemiteles 526
fulviventris, Limneria 404
fumipennis, Cryptus 526
fumosa, Calybia 366
funalis (= avellana), Cochlidion ... 369
furcatus, Hemiteles 526
furcula, Cerura 94
fuscata (marginaria *ab.*), Hybernia 64
fuscata (monoglypha *ab.*), Xylophasia 65

galactodactyla, Aciptilia ... 42, 117
galatea, Melanargia ... 12, 13
gei, Nepticula 164, 165, 168, 184, 232, 233, 234, 236. 239-242, 244
geminella, Nepticula 250
gemmaria, Boarmia ... 14, 64
Geometridae 105, 107, 109, 111, 112
Geometrides 29, 38, 63, 109
geryon, Adscita 386, 389, 390, 395, 400-406, 407
geryonis, Apanteles 404
gigas, Limnadia 24
gilvaria, Aspilates 84
γ-inversa, Cochlidion (Limacodes) 367, 368
glaucata, Cilix 78
globulariae, Rhagades 386, 389, 390, 402, 407-414
globulariae (= statices), Adscita ... 390
glutinosae, Nepticula 165, 248, 280, 281, 283-285, 286
glutinosella (= glutinosae), Nepticula 283
glycirrhizae (trifolii *ab.*), Anthrocera 415, 425, 426, 485, 487, 488
gonostigma, Orgyia ... 27, 28, 59
Gordii 440
gracilis, Hepialus 135
gracilis, Taeniocampa 39
gracilis (trifolii *var.*), Anthrocera 490, 491
graeca (purpuralis *var.*), Anthrocera 434
graminis (= lonicerae), Anthrocera 467
Grapta (= Polygonia) 49
graslini, Anthrocera 519
gratiosella (= basalella), Nepticula 299
gratiosella (=? marginicolella), Nepticula 260
gratiosella, Nepticula 165, 168, 179, 182, 203, 222, 253-256, 278
grisea, Acronycta 83

PAGE
grisea, Cochlidion (Apoda) ... 368
grisea-rosea (= anomalella), Nepticula 206
grisescens (filipendulae *ab.*), Anthrocera ... 423, 511, 513
grossularitata, Abraxas 87
guineensis, Tascia (Zygaena) ... 383
gurda (filipendulae *var.*), Anthrocera 519, 545
guttata, Artaxa 97
guttivitta, Heterocampa 48

Hallesus 104
halterata, Herea (Zygaena) ... 383
Harrisina 384, 386
Harrisonia 384, 429
headleyella, Nepticula 166, 330-332
hecta (us), Hepialus 135
hedysari, Anthrocera (Agrumenia) 415
helenus, Papilio 78
hellwigella (= thunbergella), Micropteryx 154
hemadelpha, Mnesarchaea... 138, 161
hemargyrella, Nepticula ... 298, 344
Hemileucidae ... 48, 103, 107, 125
Hepialidae 2, 106
Hepialides ... 1, 2, 5, 109, 110, 131
Hepialus 5, 36, 43, 46
hera, Callimorpha 9, 66, 126
heringi (purpuralis *var.*), Anthrocera 434, 435, 436, 438, 440, 541
Hesperiides 109
Hestiochora 388
Hesychia (= Anthrocera) 415
Heterogenea 3, 37, 180, 361, 362, 364, 377, 378
Heterogenea (= Cochlidion) ... 368
Heterogeneidae 360
Heterogenia (= Heterogenea) ... 377
Heterogyna 117
Heterogynides ... 109, 115, 117
hexadactyla, Orneodes (Alucita) ... 103
heydenreichii (? statices *var.*), Adscita 391
hilaris, Anthrocera (Hesychia) ... 415
hippocrepidis, Hb., Anthrocera (Thermophila) 415, 418, 419, 515
hippocrepidis, St., Anthrocera 416, 418, 424, 430, 480, 492, 508, 509, 513, 527, 532-538, 539, 544, 545
hippophaes, Deilephila 80
hirsutella, Sterrhopterix (fusca, Psyche) 27, 28
hirtaria, Biston 13, 14
hodgkinsoni (= centifoliella), Nepticula 267
hodgkinsoni, Nepticula 165, 183, 269
Holocentropus 161
Homoptera 87
huebnerella (? = basalella), Nepticula 229, 298-299
humuli, Hepialus 135, 397
hyalinalis, Botys 21
Hydropsyche 135, 161

PAGE
Hydropsychidae 161
Hypercallia 110
Hypsa 48

ianthina, Triphaena 39
icarus, Polyommatus ... 8, 13
ignobilella, Nepticula 165, 168, 172, 192, 222, 223, 248, 256, 276, 278-280, 305, 358
ignobiliella (= ignobilella), Nepticula... 278
ignobiliella (= turicella), Nepticula 298
ilicis, Thecla 68
immaculata, Calybia 366
immundella, Trifurcula 183, 334, 335, 354, 355-356, 357
imperfectella, Micropteryx ... 138
imperialis, Citheronia 124
inachis, Kallima 67
incerta (? globulariae *var.*), Rhagades 409
inconspicuella, Solenobia ... 27, 28
Incurvaria 36, 110
infausta, Aglaope (Zygaena) 383, 385
inferna, Cochlidion (Apoda) . 368
Ino (= Adscita) ... 386, 387, 388
Ino (= Rhagades) 384, 406
instabilis, Hemimachus 526
intermedia (conspersa *ab.*), Dianthoecia 65
intermedia (cruciata *ab.*), Heterogenea 379
intermedia (filipendulae *ab.*), Anthrocera 510, 511
interrogationis, Polygonia 11, 12
interrupta (purpuralis *ab.*), Anthrocera 433, 434
intimella, Nepticula 166, 168, 172, 177, 182, 337, 339, 341-342
io, Automeris 48
io, Vanessa 9, 16, 51, 60
Iphiclides 95
irava, Hidari 77
iris, Apatura 93
ismene, Melanitis 69
isobasella (? calthella *var.*), Micropteryx 139
isocrates, Pirachola 96
italica (= viciae *var.*), Anthrocera

jacobaeae, Euchelia 38
jamaicensis, Calybia 366
jasius, Charaxes ... 34, 82, 83
Jugatae 5
juniperatae, Apanteles 526

Kallima 71

laburnella, Cemiostoma 337
Lacosomidae 107
Lacosomides 123
Laertias... 95
laeta, Anthrocera (Hesychia) ... 415
Lagoa ... 120, 123, 362, 364
Lampronia 129

PAGE
lamprotornella, Nepticula ... 187
lanestris, Eriogaster 9, 12, 13, 99, 119, 206, 375
laphira (= filipendulae *var.*), Anthrocera 520
laphiria (= filipendulae *var.*), Anthrocera 520
laphria (= filipendulae *var.*), Anthrocera 520
lapponica, Nepticula 166, 182, 282, 293-296
lapponicella (= lapponica), Nepticula 293
larvarum, Tachina 526
Lasiocampidae 107, 111
Lasiocampides 29, 38, 109, 111, 115
latomarginata (lonicerae *var.*), Anthrocera 468
lavandulae, Anthrocera (Anthilaria) 415, 417, 424, 428
leda, Melanitis 69
lemniscella, Nepticula ... 290, 344
lemniscella (? marginicolella), Nepticula 260, 261
lepida, Parasa 365
leporina, Acronicta 11, 39, 42, 83
leptinoides, Schizura ... 81, 93
Leptoceridae 161
lethe, Euchromia (Zygaena) ... 383
leucographa, Pachnobia 39
leucophaearia, Hybernia ... 14, 64
lewini, Doratifera 98
lichenaria, Cleora 81
lichenea, Epunda 12
lichenella, Solenobia 26. 27, 28
ligniperda, Cossus 60, 86
ligula, Orrhodia 9
ligustri, Sphinx 27, 29, 30, 60, 85
Limacode (= Cochlidion) 368
Limacode (= Heterogenea) ... 377
limacodes (=avellana), Cochlidion 369, 546
Limacodes (= Cochlidion) 360, 362, 368, 477
Limacodes (= Heterogenea) ... 377
Limacodidae 360
limax (avellana *ab.*), Cochlidion 370, 374
Limbnobia... 3
linearis, Macrocentrus 526
Liparidae 366
Liparides 28, 38, 63
Lithosiidae 107, 111, 112
littoralis, Leucania... ... 9, 10, 12
litura, Anchocelis 9
logani, Cethosia 91, 92
lonicerae, Anthrocera 415, 416, 418, 419, 420, 421, 422, 423, 424, 425, 426, 428, 429, 430, 442, 454, 460, 462, 463, 466-480, 485, 486, 490, 491, 498, 500, 517, 521, 524, 537, 539, 540, 543, 544, 545
lonicerae × filipendulae, *hyb.*, Anthrocera 419, 420

PAGE
lonicerae × trifolii, *hyb.*, Anthrocera 419, 420
lonicerae *var.* (=viciae), Anthrocera 454
lonicerarum, Nepticula 216
loti (= achilleae), Anthrocera (Lycastes) 416, 417
loti (= ? cytisi *ab.*), Anthrocera ... 511
loti (= lonicerae), Anthrocera ... 467
loti (= trifolii), Anthrocera ... 483
loti (= viciae), Anthrocera ... 454
louisella (=? sericopeza), Nepticula 343
loxoscia, Mnesarchaea ... 138, 161
lubricipeda, Spilosoma ... 12, 38
lucernea, Agrotis 65
lucina, Nemeobius 18
luctuosa, Acontia 10
lugdunensis (fausta *ab.*), Anthrocera 422
lunaria, Selenia ... 14, 44, 84, 89
lutea, Pelecystoma 375
luteella, Nepticula 166, 266, 271, 281, 282, 285-287
luteicoma, Acronycta 84
luteolata, Rumia 44, 79, 84, 85, 88, 89
lutescens (hippocrepidis *ab.*), Anthrocera 533
lutescens (lavandulae *ab.*), Anthrocera 423
lutescens (lonicerae *ab.*), Anthrocera 467, 469
lutescens (purpuralis *ab.*), Anthrocera 423, 434
lutescens (trifolii *ab.*), Anthrocera 422, 487
lutescens-basalis (trifolii *ab.*), Anthrocera 488
lutescens-glycirrhizae (trifolii *ab.*), Anthrocera 488
Lycastes (= Anthrocera) 415, 443
Lymantriidae 107, 111
Lymantriides 109
Lyonetia (= Nepticula) 184
Lyonetia (= Trifurcula) 354

machaon, Papilio ... 78, 82, 94, 95
Macrurocampa 92, 96
maia, Hemileuca 48
major (lonicerae *var.*), Anthrocera 467, 468, 470, 471
Malacosoma (Clisiocampa) 58, 76, 124
malella, Nepticula 165, 171, 179, 276, 282, 302-304, 309
manani (caesia *var.*), Dianthoecia 65
mandan, Pamphila 34
mannii (filipendulae *var.*), Anthrocera 515, 544
mannii (statices *var.*), Adscita ... 391
mansuetella, Micropteryx (Eriocephala) 1, 130, 135, 137, 138, 148, 152-153, 155
margaritaria, Metrocampa ... 85
Margarodia 47
marginaria, Hybernia 64
marginicolella, Nepticula 166, 221, 226, 257, 258, 260-263, 264
marthesia, Heterocampa 49

PAGE
marthesia, Macrurocampa .. 41
maschukella, Micropteryx ... 138
media, Parasa 365, 366
medicaginis (= lonicerae), Anthrocera 539
medicaginis (? lonicerae *var.*), Anthrocera 415, 468, 470-472, 509, 517, 546
medicaginis (Ochs., *nec* Bdv.), Anthrocera 515, 516
megacephala, Cuspidia 39
megaera, Pararge 13, 18
Megalopygidae 107, 116, 119, 363
Megalopygides .. 109, 115, 117
melilothi (= viciae), Anthrocera 453, 454
meliloti (= carniolica), Anthrocera (Agrumenia) 415
meliloti (= ? palustris), Anthrocera 499
melissa, Haematerion (Zygaena) ... 383
memnon, Papilio 78
mendica, Spilosoma 28
menthastri, Spilosoma ... 13, 63
mersina (filipendulae *var.*), Anthrocera 519
Mesembrynus (= Anthrocera) 415, 416, 430
meticulosa, Brotolomia 57
micans (statices *var.*), Adscita ... 391
Microgaster 505
Micropterygidae (Eriocephalidae) 114, 133, 137, 138
Micropterygidae (= Eriocraniidae) 2
Micropterygides (= Eriocephalides) 104, 109, 110, 114, 115, 116, 129-138, 160
Micropterygides (= Eriocraniides) 1, 2, 3, 4, 5
Micropteryginae 138
Micropteryx (= Eriocephala) ... 104
Micropteryx (= Eriocrania) 1, 2, 3, 5
Micropteryx (= Micropterix) 116, 131, 132, 134, 135, 136, 137, 138-160, 162, 292
Microsetia (= Nepticula) 184
microtheriella, Nepticula 164, 165, 248, 249, 270, 271, 273, 275-277, 278, 281, 283
milhauseri, Hybocampa ... 79, 80
miniata, Calligenia 9
miniata (filipendulae *ab.*), Anthrocera 510
miniata (lonicerae *ab.*), Anthrocera 467
miniosa, Taeniocampa 39
minoides (trifolii *ab.*), Anthrocera 419, 422, 425, 426, 484, 485, 488, 512
minor (avellana *ab.*), Cochlidion 370
minor (exulans *ab.*), Anthrocera ... 449
minor (filipendulae *ab.*), Anthrocera 509
minor (lonicerae *ab.*), Anthrocera 467
minor (statices *var.*), Adscita ... 392
minos (= purpuralis), Anthrocera 430, 434, 435

PAGE
minusculella, Nepticula 165, 171, 173, 196, 197-199, 200, 201, 203, 213, 216
Mnesarchaea ... 138, 160, 161
monacha, Lymantria (Psilura) 27, 28, 38, 96
monoglypha, Xylophasia 65
montanata, Melanippe ... 88, 89
mori, Bombyx 15, 22, 25, 27, 29, 30, 37, 38, 59, 115, 121, 126, 128, 326
mucidella (? =argentipedella), Nepticula 290
mucidella, Elachista 129
muscalella, Incurvaria 36
Muscidae 78
myricae (=euphorbiae *var.*), Pharetra 10
Myrmeleon 132
myrtetella, Micropteryx ... 130, 138
myrtillella, Nepticula 166, 179, 182, 315-317, 318, 324
myrtilli, Anarta 28, 82
Mystacides 135

napi, Pieris 13
Nematois (Nemotois) 36
Nemeobius 9
nephelus, Papilio 78
Nepticula 132, 164, 165, 176, 180, 181, 182, 183, 184, 362
Nepticulidae 182-184
Nepticulides 109, 115, 162-185
Nepticulidi 184
Nepticulinae 184
Nerice 48
Neuronia 5
Neurosymploca 415
neustria, Malacosoma (Clisiocampa) 9, 12, 347
nicaeae, Anthrocera 417
nigra (crepuscularia *ab.*), Tephrosia 64
nigra (cruciata *ab.*), Heterogenea 379
nigra (monoglypha *ab.*), Xylophasia 65
nigra (repandata *ab.*), Boarmia ... 64
nigricans (hippocrepidis, *ab.*), Anthrocera 423, 487
nigricornella (= assimilella), Nepticula 350
nitidella (casta), Fumea 28
nobilis, Heterogenea 368
Noctuidae 107, 111
Noctuides 28, 38, 63, 109
Nolidae 111
Nolides 38
notata (? globulariae *var.*), Rhagades 408
nothus, Apanteles 404
Notodonta 48
Notodontidae 105, 107, 111, 112
Notodontides ... 28, 38, 109, 111
Notolophus (Orgyia) 84
nubeculosa, Cochlidion (Apoda) ... 368
nubigena (purpuralis *ab.*), Anthrocera ... 431, 434, 436, 437, 541
nupta, Catocala 66, 89
Nycteolides 109
nylandriella, Nepticula 165, 195, 196, 220-221

PAGE
oblinita, Acronycta 83
obliqua, Heterocampa 48
obliqua, Heterogenea 368
obliquella (diversa), Nepticula 183, 323-324
obliterae (conspersa *ab.*), Dianthoecia 65
obnoxius, Mestostenus 526
obscura (purpuralis *ab.*), Anthrocera 423, 434, 437
obscura (trifolii *ab.*), Anthrocera 423, 487
obscura (viminalis *ab.*), Cleoceris 64
obscurata, Gnophos ... 64, 66
obsoleta (trifolii *ab.*), Authrocera... 485
occitanica, Anthrocera ... 424, 428
ocellana, Hedya 64
ocellatus, Smerinthus 27, 29, 80, 85, 86
ochracea (menthastri *ab.*), Spilosoma 63
ochrea (conspersa *ab.*), Dianthoecia 65
ochrearia, Aspilates 84
ochsenheimeri (filipendulae *var.*), Anthrocera 418, 424, 470, 472, 508, 509, 515-518, 539, 542, 545
ochsenheimeri × filipendulae, *hyb.*, Anthrocera 420
ochsenheimeri (= hippocrepidis, St.), Anthrocera 532
oculus, Polyphemus 24
Odoneta 77
Ogyris 98
olane, Ogyris 98
oleracea, Hadena 86
onobrychis, Anthrocera (Agrumenia) 415
oo, Dicycla ... 9, 13, 38, 39
Oporabia 37
Opostega 182
Opostega (= Scoliaula) 359
orbicularia, Zonosoma 84
orbitalis, Casinaria 496
orichalcea (trifolii *ab.*), Anthrocera 485
Orna 388
Orneodes 109, 110
Ornithoptera 51
orobi (trifolii *ab.*), Anthrocera 415, 422, 486, 490
oxyacanthaecolella (= oxyacanthella), Nepticula 202
oxyacanthella, Nepticula 17, 164, 165, 187, 189, 196, 200, 202-204, 254, 255

Packardia 77, 364, 368
Palaeomicra 6, 137, 138, 160, 161, 162
pallida (exulans *ab.*), Anthrocera ... 449
pallida (hippocrepidis *ab.*), Anthrocera 533
pallidella, Trifurcula 354, 355, 356-358
pallidulella (= pallidella), Trifurcula 357
paludis (by error = palustris), Anthrocera 416, 546
palustris (trifolii-major), Anthrocera 416, 417, ? 419, ? 420, ? 422, 430, 480-483, 484, 485, 486, 487, 490, 494, 497, 499, 507, 521-523, 539, 543, 544, 546
Panorpa 5, 136
Panorpidae 132
paphia, Dryas 66
Papilio 51
papilionaria, Geometra 78, 86, 87, 88
Papilionides 39, 109
paracosma, Mnesarchaea ... 138, 161
paralekta, Kallima 67
parallela, Cochlidion (Apoda) ... 368
Pararge 9
Parasa 362
pardella, Epimartyria (Micropteryx) 137, 138, 162
pavonia, Saturnia 27, 29, 51, 121, 129, 206
paykullella (= aureatella), Micropteryx 156
paykullella, Micropteryx ... 130, 138
paykullella (= thunbergella), Micropteryx 154, 157
pectinicornis, Chalcosia (Zygaena) 383
pedaria, Phigalia 28, 29, 44
pendularia, Zonosoma 84
peunaria, Himera 14, 37
Pericopidae 107, 111
pernyi, Antheraea 59
perochraria, Acidalia 13
perpusillella (= prunetorum), Nepticula 259
perpygmaeella (=pygmaeella), Nepticula 191
persicariae, Mamestra 86
persona (dominula *var.*), Callimorpha 69
peucedani, Anthrocera (Thermophila) 415, 417, 418, 419, 422, 424, 438
phacae, Anthrocera (Agrumenia) 415
Phalaena (=Heterogenea)... ... 378
Phalaena (= Adscita) 387
phalaenarum, Telenomus 14
phegea, Zygaena (Syntomis) 383, 419
Pheocampa 87
phidippus, Amathusia 77
philarchus, Kallima 67
philodice, Colias (Eurymus) ... 51
phlaeas, Chrysophanus 13, 65, 73, 74, 75
Phobetrinae 365
Phobetron 364
pholas, Lycomorpha 384
Phryganeidae 2, 3, 4
Pieris 9
pilosellae (purpuralis), Anthrocera 431, 434, 435, 436, 437
pini, Dendrolimus 15, 16, 27, 29, 60, 69
piniperda, Panolis 82
pistacina, Anchocelis 9
pithecium, Phobetron 366
pityocampa, Cnethocampa ... 124

PAGE
plagicolella, Nepticula 165, 171, 178, 179, 228, 248, 249, 259, 260, 268, 270, 271, 272-275, 276, 278, 303
plana, Chaerotricha 97
plantaginis, Nemeophila 54
Platyptericidae 40, 49
Platypterygides 38
Platysamia 51
plumigera, Ptilophora 15
plumistraria, Eurranthis 7
pluto (purpuralis *ab.*), Anthrocera 416, 424, 434, 435
podana, Tortrix 64
podevinella (= seppella), Micropteryx 149
Polia 63
polychloros, Eugonia 11, 65, 73, 75
polygalae (purpuralis *ab.*), Anthrocera ... 424, 425, 432, 434, 435, 436, 437, 541
polymena, Euchromia (Zygaena) 383
polyphemus, Telea ... 22, 27, 29
polytes, Papilio 78
pomella, Nepticula ... 165, 189-191
populella (= trimaculella, *ab.*), Nepticula 348
populi, Poecilocampa 85
populi, Smerinthus 10, 22, 27, 29, 99, 125
porcellus, Choerocampa 91
Porthesia 100
posticella (?=ignobilella), Nepticula 278
potatoria, Cosmotriche (Odonestis) 27, 29, 60, 129, 412
poterii, Nepticula 165, 183, 227, 248-250, 251, 276
pratorum (= ? trifolii), Anthrocera 483
pretiosa, Nepticula 241
processionea, Cnethocampa ... 124
proconfluens (filipendulae *var.*), Anthrocera 512
Procris (= Adscita) ... 387, 388
Procris (= Rhagades) 406
promethea, Callosamia 128
pronuba, Triphaena 12, 13, 39, 59, 66
prunetorum, Nepticula 165, 259-260, 273, 274, 303
pruni, Odonestis (Lasiocampa) 15, 16
pruni, Rhagades (Adscita)... ... 387
pruni, Thecla 14
pseudargiolus, Cyaniris 98
pseudobombycella, Talaeporia 27, 28
Pseudoipsidae 111
Pseudoprocris 388
psi, Triaena (Acronycta) ... 57, 64
Psocidae 2
Psocus 2
Psychidae 2, 30, 107
Psychides 2, 3, 28, 109, 111, 115, 117
Pteromalina 505
Pterophorides 103, 107, 109, 115, 116, 117
Pterophorus... ... ... 109, 110
pudibunda, Dasychira 12, 96, 100

PAGE
pugione, Empyreuma (Zygaena) ... 383
pulchra (exulans *ab.*), Anthrocera 425, 448
pulverosella, Nepticula 165, 192, 292, 334, 335, 336, 358
pulverulenta (cruda), Taeniocampa 38, 39
punctum, Anthrocera (Mesembrynus) ... 416, 424, 434, 435
purpuralis (minos), Anthrocera (Mesembrynus) 416, 417, 418, 421, 422, 424, 425, 427, 429, 430-443, 445, 446, 448, 456, 458, 488, 509, 539, 540, 541, 542
purpurascens (calthella, *ab.*), Micropteryx 139
purpurascens, Hepialus 135
purpurella, Eriocrania ... 104, 130
pusilella (= calthella), Micropteryx 139
pustulata, Phorodesma 90
puta, Agrotis 39
pygmaea, Calybia 366
pygmaeella, Nepticula 165, 168, 182, 187, 189, 191-193, 254, 255, 278, 279, 334, 358
pylotis, Calodesma 383
Pyralidae 103, 107
Pyrameis 76
pyri, Nepticula 165, 171, 173, 198, 199-201, 203
pyri, Saturnia 27, 29, 51
pyrina, Zeuzera 12
Pyromorpha 384
Pyromorphidae ... 107, 116, 385
Pyromorphinae 383, 384
pythia (= purpuralis), Anthrocera 434

quadricornis, Ceratomia 124
quadrimaculella, Scoliaula 257, 359-360
querceti, Euclea 366, 367
quercifolia, Eutricha (Gastropacha) 22, 26, 27, 29, 49, 68, 82, 85, 129
quercinaria, Ennomos 12, 15, 44, 89
quercûs, Lasiocampa 12, 27, 29, 54, 100, 122, 129, 375
quercûs, Zephyrus 14, 39, 68
quinquejuncta (filipendulae *ab.*), Anthrocera 512
quinquella, Nepticula 165, 175, 182

rablensis, Micropteryx 138
radcliffei, Acronycta 84
ramburii (filipendulae *var.*), Anthrocera ... 512, 518, 519
rectangulata, Eupithecia 64
regalis, Citheronia 93
regiella, Nepticula 165, 168, 172, 179, 221-223, 224, 225, 254, 279, 305
repandata, Boarmia 64
retractata, Cochlidion (Apoda) ... 368
rhadamanthus, Anthrocera (Eutychia) 415
Rhagades ... 386, 388, 406-407
rhamni, Gonepteryx 9

PAGE
Rhyacophila... ... ... 6, 161
Rhyacophilidae 161
roccoae, Declana 81
romanovi (dominula *var.*), Callimorpha 69
romeo *var.* nevadensis *gyn.*, Anthrocera 422
rosella (=anomalella), Nepticula... 206
rothenbachii, Micropteryx... ... 138
rubescens, Nepticula 263
rubi, Macrothylacia (Lasiocampa) 13, 14, 100, 127
rubicundus, Anthrocera ... 539, 541
rubicundus (? purpuralis *var.*), Anthrocera 416, 434, 435, 436, 437
rubiginea, Dasycampa 12
rubivora, Nepticula 165, 171, 175 248, 304, 305, 310-313
rubrifasciella (=thunbergella), Micropteryx... ... ... 153, 154
rufella (=trimaculella), Nepticula 348, 350
ruficapitella, Nepticula 165, 172, 173, 179, 183, 186, 187-189, 191, 192, 204, 205, 219, 243
rufimitrella, Adela 36
rufocinctus (= instabilis), Hemimachus 526
rumia, Kallima 67
rumicis, Pharetra 10
russula, Euthemonia ... 9, 38

sagittata, Cidaria 82
salicana, Antithesia 78
salicis, Leucoma ... 13, 38, 97
salicis, Nepticula 166, 168, 169, 174, 178, 179, 183, 264, 288, 293, 315, 316, 317-320, 321, 325
salicis (= obliquella), Nepticula 323, 324
salicis (= vimineticola), Nepticula 320
salicivorella (= ? salicis), Nepticula 318
salopiella, Eriocrania 130
sambucaria, Uropteryx ... 40
samiatella (= ? atricapitella), Nepticula 185, 186
samiatella, Nepticula 166, 198, 219
samiatella ♀ (= ? ruficapitella), Nepticula 187
sangii, Eriocrania 130
sarpedon, Anthrocera (Lycastes) 416, 417, 423
Saturniidae ... 105, 107, 123, 129
Saturniides ... 29, 109, 115, 123
Satyridae 41
saucia, Peridroma.. ... 12, 39
scabiosae, Anthrocera (Mesembrynus) 416, 424, 425, 438
scabiosae (= palustris), Anthrocera 499
Schizura 48
Schizurae 81, 91
scintillans, Artaxa 97
scitella, Cemiostoma 337
Scoliaula (Bohemannia) 164, 182, 183, 358-359

PAGE
Scolytidae 43, 77
sedi, Anthrocera (Lycastes) 415, 416
selene, Actias 59
semicolorella (gei *ab.*), Nepticula 232, 234
semilutescens (lonicerae *ab.*), Anthrocera 469
semilutescens (trifolii *ab.*), Anthrocera 487
semipurpurella, Eriocrania (Micropteryx) ... 1, 130, 135
separata (purpuralis *ab.*), Anthrocera 434
seppella (? aruncella *var.*), Micropteryx (Eriocephala) 1, 130, 135, 136, 137, 138, 139, 145, 146, 147, 148, 149-152
septembrella, Nepticula 163, 166, 169, 179, 182, 334, 335, 336-338, 339, 341, 346
sequella, Tinea 348
serella, Nepticula 165, 227, 228, 245-246
sericidactylus, Leioptilus 42
sericopeza, Nepticula 166, 171, 184, 343-346, 348, 350
sericopeza (= argyropeza), Nepticula 327
Sericostoma 135
seriziati (palustris *var.*), Anthrocera 471, 490, 539, 543, 544
serotinella, Trifurcula 355
serotinus, Sphinctus 375
Sesia (= Macroglossa) 48
Sesiidae 107
Setodes 135
sexmaculata (palustris *ab.*), Anthrocera 500
sexmaculata-confluens (palustris) *ab.*), Anthrocera 500
sexpunctata (viciae *ab.*), Anthrocera 455
shurtleffi, Heterogenea 368
Sibine 364
sibylla, Limenitis 8
sicula (? viciae *var.*), Anthrocera 458, 460
similis, Porthesia ... 13, 38, 96, 100
simplicella, Nepticula 179
sinapis, Leucophasia 11
slossoniae, Calybia... ... 365, 366
smaragdaria, Phorodesma... 38, 90
Smerinthus 38, 43
solana, Rhagades 409
Solenobiides 28
sorbi, Nepticula 165, 196, 287-289, 294
Spalgis 101
sparrmanella, Eriocrania ... 130, 135
spartiata, Chesias 14
spartifoliella, Cemiostoma (Opostega) 344, 357
Sphinges-Adscitae ... 383, 388
Sphingicampa 40, 93
Sphingidae... ... 48, 105, 107
Sphingides 29, 47, 109, 114, 115, 125
Sphinx 37, 125, 126
Sphinx (= Adscita) 387
Sphinx (=Anthrocera) 414

PAGE
Sphinx-béliers 383
spicae, Anthrocera (Anthilaria) ... 415
spilodactyla, Aciptilia 117
spinuloides, Adoneta 366
splendidissima (=splendidissimella), Nepticula 243-245
splendidissimella, Nepticula 164, 165, 171, 175, 179, 235
sponsa, Catocala 89
squamatella (immundella *ab.*), Trifurcula 183, 355
Staphylinidae 77
statices, Adscita 38, 383, 384, 386, 387, 388, 389, 390-400, 401, 402, 407, 430, 444, 497
statices (= geryon), Adscita ... 400
staticus (= statices), Adscita ... 390
Stauropus 92, 93
stellatarum, Macroglossa 99
Stenophylax... 135
stentzii (viciae *ab.*), Anthrocera 456, 457, 459, 542
stettinensis (? minusculella *var.*), Nepticula 198
stimulea, Empretia ... 122, 367
stipella, Microsetia (Tinea) ... 184
stoechadis (=caucasia), Anthrocera 490
stoechadis (=medicaginis), Anthrocera ... 470, 471, 472, 486
strataria (prodromaria), Amphidasys 12, 13, 14
striata (exulans *ab.*),Anthrocera 425, 448
styx, Saliunca (Zygaena)... ... 384
subammanella, Micropteryx ... 130
subapicella (= argyropeza), Nepticula 166, 183
subapicella, Nepticula ... 328, 330
subbimaculella, Nepticula 163, 165, 172, 175, 177, 179, 182, 219, 292, 342, 348, 351, 352-354
subnitidella, Nepticula 348
subochracea (exulans *var.*), Anthrocera ... 446, 447, 448
subpurpurella, Eriocrania 130
suffusa (aglaia *ab.*), Argynnis ... 66
sulcatella (= calthella), Micropteryx 138, 139
sulphurea (avellana *ab.*), Cochlidion 370
sylvinus, Hepialus 10, 135
Symmerista 91
Syntomidae (=Euchromiidae) ... 383
Syntomis 383
syracusia (trifolii *var.*), Anthrocera 471, 486, 488-490, 494, 503, 539, 544

Tachina 50
Tantura 388
tau, Aglia 40, 91, 103
Telenomus 14
tengströmi, Nepticula 165, 183, 246-248, 546

PAGE
Tenthredinidae 46
tenuicornis, Adscita 387
tenuicornis (=geryon), Adscita 400, 404
tenuitarsum, Anomalon ... 477, 526
Tephrosia 7
teriolensis (=viciae *var.*),Anthrocera 458-459
Termes 2
Termitidae 2
testacea, Heterogenea 77
testata, Cidaria 14
testudinana (=avellana),Cochlidion 369
tetralunaria, Selenia ... 14, 15
tetraspilaris, Cochlidion (Apoda) ... 368
Thermophila (=Anthrocera) 415, 453
thetis, Curetis 96
thetis, Heliura 383
thrax, Erinota 101
thunbergella (rubrifasciella), Micropteryx (Eriocephala) 1, 130, 135, 137, 138, 152, 153-156, 157
Thyatira 8
Thyatiridae (Cymatophoridae) 107, 109, 111
Thyrididae 107
thyrsis, Gangara 101
tibialis, Melittia 383
tiliae, Nepticula 166, 179, 198, 213, 215-217, 218, 219
tiliae, Smerinthus 29
tiliella (=tiliae), Nepticula ... 198
Tinea 362
Tineidae 107
Tineides 63, 109
Tinodes 135
Tipulae 3
Tipulariae 3
Tipulidae 2, 77
Tischeria 59, 292
tityrella (=basalella), Nepticula 298, 299, 302
tityrella, Nepticula 276, 278, 323, 324
tityrella (=turicella), Nepticula 297, 298, 303
tormentillella, Nepticula 184, 226-228
tormentillella (=serella), Nepticula 246
torminalis, Nepticula 165, 223-224
Tortricidae 107
Tortricides 63, 109, 366
Tortricidia 368
Tortrix (=Cochlidion) 368
Tortrix (=Heterogenea) 377
transalpina (ferulae), Anthrocera (Thermophila) 415, 418, 419, 424, 515
transalpina (=ochsenheimeri), Anthrocera 516
tremula (dictaea), Leiocampa ... 38
Trichogramma 14
tricinctella (=aureatella), Micropteryx 156
tricolor, Ceratosia 51
tridens, Triaena 10, 11

PAGE
trifolii, Anthrocera 38, 415, 418, 421, 423, 424, 425, 426, 427, 428, 429, 430, 440, 455, 456, 458, 460, 462, 463, 465, 467, 470, 471, 478, 480-499, 502, 506, 507, 508, 520, 524, 525, 527, 537, 538, 539, 540, 543, 544, 545
trifolii *ab.* confluens × orobi, *gyn.*, Anthrocera 422
trifolii × filipendulae, *hyb.*, Anthrocera 418
trifolii, Lasiocampa ... 15, 29
trifolii × lonicerae, *hyb.*, Anthrocera 419, 420
trifolii-major, Anthrocera, *vide* palustris, A.
trifolii (=palustris), Anthrocera ... 417
Trifurcula 164, 182, 183, 354
trigona, Cochlidion (Apoda) ... 368
trigonellae (ephialtes *ab.*), Anthrocera 422
trimaculella, Nepticula 166, 175, 348-350, 351
triquetrella, Solenobia ... 26, 27, 28
tritona, Acronycta 83
trivittata (filipendulae *ab.*), Anthrocera 509
trivittata (lonicerae *ab.*), Anthrocera 468
trivittata (trifolii *ab.*), Anthrocera 425, 426, 468, 482, 485, 488
turbidella, Nepticula ... 179, 327
turcosa (statices), Adscita ... 388, 390
turicella, Nepticula 267, 281, 283, 284, 297-299, 300, 301, 354
turicella (=tityrella), Nepticula 165, 172, 178, 184
turicensis (=turicella), Nepticula 297, 298
typica (cruciata *ab.*), Heterogenea 379

ulmivora, Nepticula 166, 257-259, 261
uncula, Heterogenea ... 368
undulata, Chrysopyga ... 37, 126
unicincta, Limneria 382
unicolor, Canephora (graminella, Psyche) 27, 28
unicolor, Heterocampa 41
unicolor, Scopelodes 366
unicornis, Schizura 81
unifasciata, Emmelesia 79
unimaculella, Eriocrania ... 130, 135
uralensis (statices *var.*), Adscita ... 392
Uraniidae 105
urticae, Aglais ... 39, 50, 51, 54
urticaella (=calthella), Micropteryx 139

vaccinii, Orrhodia 9, 13
valesina (paphia *var.*), Dryas ... 66
vanadis (= exulans), Anthrocera 444
vanadis (exulans *var.*), Anthrocera 446, 447, 448
velleda, Tolype 111
vernaria, Iodis 12, 13, 78
versicolor, Endromis 10, 13, 92, 124, 129
vetulata, Scotosia 15
viciae × filipendulae, Anthrocera 420
viciae × hyb. (lonicerae × trifolii), Anthrocera 420
viciae (meliloti), Anthrocera (Thermophila) 415, 416, 420, 421, 422, 423, 424, 429, 430, 453-466, 473, 482, 490, 520, 539, 540, 542, 543, 545
vidua, Casinaria 496
villica, Arctia 27, 28, 38
viminalis, Epunda (Cleoceris) ... 64
vimineticola, Nepticula 166, 169, 174, 178, 183, 318, 319, 320-322
vimineticola (= obliquella), Nepticula 323
vimineticola (=? salicis), Nepticula 317
Viminidi 12
vinula, Cerura 10, 28, 34, 94, 95, 97, 375, 380
violacella, Tinea 185
virgularia, Acidalia 14, 64
viridana, Tortrix 79, 80
viridaria (aenea), Phytometra 8, 10
viridis (geryon *ab.*), Adscita ... 401
viridis (globulariae *ab.*), Rhagades 408
viridis (statices *ab.*), Adscita ... 390
viscerella, Nepticula 166, 187, 192, 193-194, 195, 196, 216, 257, 258, 259, 340
vitellina, Artaxa 97
vulgaris, Blepharides 505
vulgaris, Exorista 526
vulnerans, Doratifera 98, 363, 364, 365
vulpina, Acronycta 83

w-album, Thecla ... 8, 10, 13, 14
weaveri, Nepticula 163, 166, 171, 179, 182, 346-347
wockei, Micropteryx 138
woolhopiella, Nepticula 165, 173, 292-293

xanthomista *var.* nigrocincta, Polia 15
xerampelina, Cirrhoedia ... 11, 13
Xylinodes 48

yama-mai, Antheraea ... 34, 59
ytenensis (=viciae), Anthrocera ... 454

Zeuzera 43, 106
Zeuzerides 63, 109
zonodoxa, Palaeomicra 138
Zonosoma 110
Zutulba 415
Zygaena (=Adscita) 387
Zygaena (=Anthrocera) 383, 384, 414
zygaenarum, Apanteles 526
zygaenarum, Cryptus ... 496, 505
Zygaenidae 383
Zygaenidae (=Euchromiidae) ... 49
Zygaenides (=Anthrocerides) ... 38
Zygaeninae 383

THE ENTOMOLOGIST'S LIBRARY.

Books written by J. W. Tutt, F.E.S.

The British Noctuæ and their Varieties

(Complete in 4 Vols. Price 7/- per Volume).

The four volumes comprise the most complete text-book ever issued on the Noctuides. It contains critical notes on the SYNONYMY, the ORIGINAL TYPE DESCRIPTIONS (or the descriptions of the original figures) of every British species, the type descriptions of all known VARIETIES and ABERRATIONS of each species, tabulated diagnoses and short descriptions of the various phases of VARIATION of the more polymorphic species, all the data known concerning the OCCURRENCE of the rare and reputed British species. There are also complete notes on the lines of development of the general variation observed in the various families and genera; the geographical range of the various species and their varieties, as well as special notes by lepidopterists who have paid particular attention to certain species.

Each volume has an extended introduction. That to Vol. I. deals with "general variation and its causes"—with a detailed account of the action of natural selection in producing melanism, albinism, etc. That to Vol. II. deals with "The evolution and genetic sequence of insect colours," the most complete review of the subject published. That to Vol. III. deals with "Secondary Sexual Characters in Lepidoptera," containing, so far as is known, a consideration of the organs (and their functions) included in the term. That to Vol. IV. deals with "The classification of the Noctuæ, with a comparison of the Nearctic and Palæarctic Noctuides."

The first subscription list comprised some 200 of our leading British lepidopterists. The work is invaluable to all working collectors who want the latest information on this group. It contains large quantities of material collected from foreign magazines and the works of old British authors, arranged in connection with each species, and not to be found in any other published work.

Melanism and Melanochroism in British Lepidoptera

(Bound in Cloth. Price 2/6).

Deals exhaustively with all the views brought forward by scientists to account for the forms of Melanism and Melanochroism, contains full data respecting the distribution of melanic forms in Britain, and theories to account for their origin; the special value of "natural selection," "environment," "heredity," "disease," "temperature," etc., in particular cases. Lord Walsingham, in his Presidential Address to the Fellows of the Entomological Society of London, says, "An especially interesting line of enquiry as connected with the use and value of colour in insects, is that which has been followed up in Mr. TUTT's series of papers on 'Melanism and Melanochroism.'"

British Butterflies

(Illustrated. Crown 8vo. Cloth, Gilt. Price 5/-).

This book consists of 476 pages, contains 10 full-page illustrations, and 45 woodcuts. There are figures of every British butterfly. Sometimes three or four figures of the same butterfly to illustrate the two sexes, underside, and variation are given. The full-page illustrations, and most of the wood-cuts, have been drawn by the well-known entomological artist, Mr. W. A. Pearce.

Each British butterfly is described under the following heads: (1) Synonymy, (2) Imago. (3) Variation (with summarised diagnoses of all described forms), British and Continental. (4) Egg. (5) Larva. (6) Pupa. (7) Time of appearance. (8) Habitat and Distribution. Besides these there are extended remarks on each of the Tribes, Subfamilies, Families, Divisions and Superfamilies. The descriptions of the "Larvæ" and "Pupæ" are mostly original. There are 282 aberrations and varieties diagnosed, of which 111 are described for the first time.

At the end of each chapter is a brief summary giving the following information, in tabular form, for each species: I. Dates for finding (1) The ovum, (2) The larva, (3) The pupa, (4) The imago. II. The Method of Pupation. III. Food-plants.

The preliminary chapters consist of a series of short essays on the structure, etc., of the Egg, Larva, Pupa, etc., also others on practical work—Collecting, Pinning, Setting, Storing, Labelling, etc.

Monograph of the Pterophorina

(Demy 8vo. Bound in Cloth. Price 5/-).

A full account of every British Plume moth under the following heads: SYNONYMY, IMAGO, VARIATION, EGG, LARVA, FOOD-PLANTS, PUPA, TIME OF APPEARANCE, LOCALITIES, DISTRIBUTION, with full instructions for collecting, setting, and preserving these delicate insects.

Stray Notes on the Noctuæ (Price 1/-).

This contribution to our knowledge of the British NOCTUIDES should be read by all entomologists, It contains detailed information, among others, of the following points: VARIETIES AND ABERRATIONS—The local races peculiar to Britain—True distinction between Varieties and Aberrations—Types of Species—Scientific usage of the term "type," and its general application—Full notes on the Orrhodias, *Leucania straminea*, and other species in the British Museum—Identical North American and British species of Noctuæ—Representative North American Species—The genitalia of Noctuides—Identical Japanese and British Noctuids—Classification of the Noctuæ—Arrangement of Genera—Criticism of the various methods of classification which has been introduced into England—*Cymatophoridae* and *Bryophilidae*—Separation of *Leucania* and *Nonagria*—Position of the *Plusidae*—The position of the Deltoides among the Noctuæ. Many other matters of interest are also discussed.

Insects and Spiders (Crown 8vo. Illustrated. Price 1/-).

This book consists of 15 chapters, giving structural and characteristic details of the various orders of insects. These are entitled—"General external character of insects," "Internal organs of insects and their functions," "Metamorphoses of insects," "The Earwig," "Locusts and Grasshoppers," "Dragonflies," "Caddis-flies," "Butterflies and Moths," Beetles," "Flies," "Social Insects—bees, wasps and ants," "The Honey-bee," "Wasps," "Ants," and "Spiders."

Notes on the Zygænidæ (1/-).

These papers contain a full account of the synonymy, variation and distribution of several species of Burnet Moths common to Britain and the Alps.

Rambles in Alpine Valleys,

BEING THE WANDERINGS OF A FIELD-NATURALIST IN PIEDMONT

(Crown 8vo. Bound in Cloth, with Map and Photographs of District. 3/6).

The book deals with the lovely valleys which open out on the Italian side of Mont Blanc. It deals with the natural objects of interest—entomological, botanical, ornithological, and geological. It contains the most recent scientific discoveries and suggestions relative to the objects described.

It contains much scientific entomology apart from the actual description of the insect fauna of the district—the chief insects discussed with relation to their environment—are the Anthrocerids, the Parnassids, the Gnophids, the Coliads, the Erebiids, the Argynnids, etc. The origin of the coloration of Alpine insects, the sexual dimorphism presented by them, and the explanations thereof are important features in the book.

Random Recollections of Woodland, Fen and Hill

(Crown 8vo. Illustrated. Cloth. Price 2/6, a few copies of the 1st edition, 3/-).

The collecting expeditions of an entomologist into various well-known localities in various parts of the British Islands—Wicken, Cuxton, Chattenden, Freshwater, Deal, Sandwich, Dover, the Medway Marshes, Argyllshire, etc.—with full account of the fauna of these localities.

Woodside, Burnside, Hillside and Marsh

(Crown 8vo. Illustrated. Bound in Cloth. Price 2/6).

A similar series of collecting expeditions into well-known entomological and natural history localties, with description of botanical, geological, ornithological as well as entomological matters of interest to be found therein. The places dealt with include Cobham Woods, Cuxton Downs, Western Highlands, Cliffe, all well-known for their rich entomological fauna.

The "Record" Label List of British Butterflies.

Arranged after the most recent systems suggested.
Printed on one side of the paper only.
For labelling cabinets.
Copies 7 for 6d., 3 for 3d. Not less than 3 sent (Postage ½d.).

The Entomologist's Record and Journal of Variation.

An Illustrated Monthly Magazine of General Entomology.

Edited by J. W. TUTT, F.E.S.

Assisted by H. St. JOHN K. DONISTHORPE, F.Z.S., F.E.S. (Coleoptera), and MALCOLM BURR, F.Z.S., F.E.S. (Orthoptera, etc.).

Published on the 15th of each month. Recently enlarged to 28 pages. Double numbers post free to Subscribers. Subscription price, 7s. per volume (including Special Index, with every reference to aberrations, varieties, species, genera, etc.).

The leading articles written by the first entomologists of the day. In the last Volume (X.) among other contributors were—Prof. T. Hudson Beare, B.SC., M.R.S.E., F.F.S., E. A. Bowles, M.A., F.E.S., H. Rowland Brown, M.A., F.E.S., Dr. T. A. Chapman, F.Z.S., F.E.S., Prof. Harrison G. Dyar, PH.D., Rev. H. S. Gorham, M.A., F.R.S., F.E.S., Prof. A. Grote, M.A., Dr. Joseph L. Hancock, Rev. W. F. Johnson, M.A., F.E.S., Rev. F. E. Lowe, M.A., F.E.S., Prof. E. B. Poulton, M.A., F.R.S., F.Z.S., etc., Prof. Enzio Reuter, PH.D., F.E.S., Dr. W. S. Riding, B.A., F.E.S., Hon. N. C. Rothschild, B.A., F.E.S., E. F. C. Studd, M.A., B.C.L., F.E.S., Rt. Hon. Lord Walsingham, M.A., LL.D., F.R.S., etc.

Each month there are numerous short notes under the following heads: "Coleoptera," "Orthoptera," "Scientific Notes and Observations," "Life-histories, Larvæ, etc.," "Variation," "Notes on Collecting," "Practical Hints—Field work for the month," "Current Notes," "Notices of Books," etc.

All the above works to be obtained of Mr. H. E. PAGE, F.E.S., "Bertrose," Gellatly Road, St. Catherine's Park, S.E.

The Practical Scientific Cabinet Makers.

J. T. CROCKETT & SON,

ESTABLISHED since 1847,

MAKERS OF EVERY DESCRIPTION OF

CABINET CASES AND STORE BOXES.

Apparatus and Appliances for the use of Specimens for Entomologists, Botanists, Ornithologists, Geologists, Mineralogists, Numismatists, Conchologists, etc.

And for the use of Lecturers, Science Teachers, College Students, &c.

MUSEUMS FITTED AND ARRANGED.

SPECIALLY MADE CABINETS FOR BIRDS' EGGS AND SKINS.

The Drawers graduate in Depth and are interchangeable.

Store Boxes, fitted with Camphor Cells, 2/3, 3/6, 4/3, 5/3. Setting Boards, flat or oval, 1-in. 5d., 1½-in. 7d., 2-in. 9d., 2½-in. 11d., 5½-in. 1/2, 4-in. 1/4, 5-in. 1/8. Plain Ring Nets, wire or cane, 1/6, 2/-, 2/3. Folding Nets, 3/-, 4/-. Umbrella Nets, self-acting, 6/9. Pocket Boxes, 6d., 8d., 11d., 1/-. Sugaring Tins, with brush, 1/4, 1/10. Setting Houses, flat or oval boards, 8/6, 10/-. Cork Back, 12/9. Breeding Cages, 2/3. Improved Style, fitted with tanks, 3/7. Coleopterist Collecting Bottles, 1/4, 1/6. Insect and Egg Cases, from 2/3 to 10/-. Best Steel Forceps, 1/5 pair. Taxidermists' Companion, containing eight useful articles for Skinning, 9/6. Egg Drills, from 3d. Blow Pipes, from 2d. to 5d. Zinc Relaxing Boxes, 8d., 11d. Nested Chip Boxes, 4 doz. 7d. Entomological Pins, from 1/- per oz. Zinc Larvæ Boxes, 8d., 11d., 1/5. Best White Cement, 5d. a bottle. Special Cork Carpet, 9d. per square foot. Cabinet Corks, 7-in. by 3½-in. 11d. and 1/2 per dozen sheets. The "Perfection" Flat Setting Boards, for English Style of Setting—supersedes the Old Boards—same prices as ordinary Setting Boards.

All Goods not approved may be exchanged, or money returned. All Goods Store Prices. All Best Work. Estimates given. Great Advantages in dealing direct with Makers.

Send for Full Detailed Price List before ordering elsewhere.

7a, PRINCES STREET, CAVENDISH SQUARE, LONDON, W.
Factories—34, RIDING HOUSE STREET and OGLE STREET, W.

WATKINS & DONCASTER,

Naturalists and Manufacturers of Entomological Apparatus and Cabinets.

N.B.—For Excellence and Superiority of Cabinets and Apparatus, references are permitted to distinguished Patrons and Colleges, &c. Catalogues (66 pp.) sent post free on application.

NOW READY.—The Exchange List and Label List, Compiled by Ed. Meyrick, B.A., F.L.S., F.E.S., according to his recent "Handbook of British Lepidoptera." Exchange Lists, 1d. each, 4d. per doz., or 2/6 per 100. Label Lists, 1/- each.

Plain Ring Nets, Wire or Cane, including stick, 1/3, 2/-, 2/6
Folding Nets, 3/6 and 4/-
Umbrella Nets (self-acting), 7/-
Pocket Boxes, 6d.; corked both sides, 9d., 1/-, and 1/6
Zinc Relaxing Boxes, 9d., 1/-, 1/6, and 2/-
Nested Chip Boxes, 4 dozen, 8d., 1/9 gross
Entomological Pins, mixed, 1/6 per oz.
Sugaring Lanterns, 2/6 to 9/6
Sugaring Tin, with brush, 1/6, 2/-
Sugaring Mixture, ready for use, 1/9 per tin.
Mite Destroyer (not dangerous to use), 1/6 per lb.
Store Boxes, with Camphor Cells, 2/6, 4/-, 5/-, and 6/-
Ditto, Book Pattern, 8/6, 9/6, and 10/6
Setting Boards, flat or oval, 1-in., 6d.; 1½-in., 8d; 1¾-in., 9d.; 2-in., 10d.; 2½in. 1/-; 3-in., 1/2; 3½-in., 1/4; 4-in., 1/6; 4½-in., 1/8; 5-in., 1/10. Complete set of 14 boards, 10/6
Setting Houses, 9/6 and 11/6; corked back, 14/-
Zinc Larva Boxes, 9d., 1/-
Brass Chloroform Bottle, 2/6
Breeding Cage, 2/6, 4/-, 5/- and 7/6
Taxidermist's Companion, *i.e.*, a pocket leather case, containing most useful instruments for skinning, 10/6
Scalpels, 1/3; Label Lists of Birds' Eggs, 3d., 4d., 6d.
Scissors, per pair, 2/-
Setting Needles, 3d. and 6d. per box
Coleopterist's Collecting Bottle, with tube, 1/6, 1/8
Botanical Cases, japanned double tin, 1/6, 2/9, 3/6, 4/6, 7/6
Botanical Paper, 1/1, 1/4, 1/9 and 2/2 per quire
Insect Cases, imitation mahogany, 2/6 to 11/-
Cement for replacing Antennæ, 6d. per bottle
Forceps for removing Insects, 1/6, 2/-, 2/6 per pair
Cabinet Cork, 7 x 3½, best quality, 1/4 per dozen sheets
Pupa Diggers, in leather sheath, 1/9
Insect Lens, 1/- to 8/-
Glass Top and Glass Bottomed Boxes, from 1/4 per dozen
Label Lists of British Butterflies, 2d.
Ditto Land and Fresh-water Shells, 2d.
Egg Drills, 2d., 3d., 1/-; Metal Blow-pipe, 4d. and 6d.
Our New Label List of British Macro-Lepidoptera, with Latin and English Names, 1/6. Our new Catalogue of British Lepidoptera (every species numbered, 1/-; or printed on one side for Labelling, 2/-)

All Articles enumerated are kept in stock, and can be sent immediately on receipt of order.

THE "DIXON" LAMP NET (invaluable for taking moths off Street Lamps without climbing the Lamp Posts), 2/6.

CABINETS. *Special Show Rooms.*

The following are the prices of a few of the smaller sizes; for measurements and larger sizes see Catalogue.

	Insects.	Eggs.	Minerals and Dried Plants, Fossils, &c.
4 Drawers	13/6	12/-	10/6
6 „	17/6	16/6	15/-
8 Drawers	33/-	30/-	25/-
10 „	45/-	56/-	45/-

A LARGE STOCK OF INSECTS & BIRDS' EGGS.

Birds, Mammals, &c., Preserved and Mounted by First-class Workmen.

36, STRAND, W.C. (5 doors from Charing Cross).